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VOL. 25, NOS. 3 AND 4 DECEMBER, 1954

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AGRICULTURAL JOURNAL

PREPARED BY THE
DEPARTMENT OF AGRICULTURE
COLONY OF FIJI

Anniversary Issue

[1955]

Notes for Libraries and Research Institutes

FORMER ISSUES OF AGRICULTURAL JOURNAL

So many requests are received from abroad for parts of the "Agricultural Journal" which were never published that the following list of all issues published and those which are not now available is given for reference. Attention is especially directed to Volume 7 which had only one part :—

Vol.			
1.	3	numbers,	1928.
2.	4	,,	1929.
3.	3	,,	1930 (none).
4.	4	,,	1931.
5.	2	,,	1932 (none of No. 2).
6.	2	,,	1933.
7.	1	,,	1934.
8.	4	,,	1935-7 (none of No. 4).
9.	4	,,	1938 (none of Nos. 2, 3 and 4).
10.	4	,,	1939 (none of Nos. 2 and 4).
11.	4	,,	1940 (none)
12.	4	,,	1941 (none of Nos. 1 and 2).
13.	4	,,	1942.
14.	4	numbers,	1943.
15.	4	,,	1944.
16.	4	,,	1945.
17.	4	,,	1946 (none of No. 1).
18.	4	,,	1947 (none of No. 1).
19.	4	,,	1948 (Nos. 3 and 4 form a double issue).
20.	4	,,	1949.
21.	3	,,	1950 (none of Nos. 1 and 2 combined).
22.	1	,,	1951.
23.	3	,,	1952. (one double issue).
24.	2	,,	1953. (two ,, ,,).
25.	2	,,	1954. (two ,, ,,).

ISSUES OF AGRICULTURAL CIRCULAR

NUMBERS and year of issue of the "Agricultural Circular" :—

Vol. 1, 1920, 12 numbers. Vol. 4, 1923, 1 number.
2, 1921, 5 ,, 5, 1924-5, 2 numbers.
3, 1922, 4 ,,

As number 4 of Vol. 3 was printed as "Volume 4" and number 1 of Vol. 4 as "Volume 5" it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

ANNUAL BULLETINS

THE Annual Bulletin of Divisional Reports ran from 1931 to 1938 and was then discontinued.

OLD ISSUES OF AGRICULTURAL BULLETINS

FREE copies of the following Bulletins are available to Colonial Departments of Agriculture research institutes and bona fide planters within the Colony.

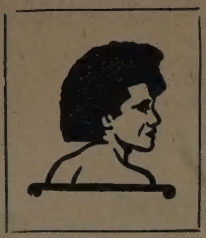
No. 1. Sisal Hemp in Fiji, 1911.
3. Rhinoceros Beetle in Samoa, 1912.
4. The Banana in Fiji, 1912.
5. Scale Insect on Bananas, 1913.
6. Lemon Grass, 1913.
7. A Mission to Java for a Coleopterous Pest of Bananas, 1914.
8. Coconut Experiments, 1915.
9. Soils of Fiji—I, 1916.
11. Alluvial Soils of Fiji, 1919.
12. Leaf Moth of Coconuts, 1919.
13. Sea Island Cotton, 1920.
14. Transparent Coconut Scale, 1921.
15. Purple Leaf Moth of Coconuts, 1924.
18. Control of Coconut Spike Moth, 1935.

The following are available to the public at the prices shown—

No. 21. Biological Control of the Rhinoceros Beetle, 1941. Price 1s.
21A. Fijian Plant Names, 1942. Price 3s. 6d., 4s. and 6s.
22. An introduction to the Mosquitoes of Fiji, 1943. Price 1s.
23. Insect Pests in Fiji, 1946. Price 1s.
Gardening Notes, Insect Pest Control and Plant Diseases, 1945. Price 1s.
24. The Botanical Gardens, Suva, 1948. Price 1s. 6d.
25. Observation on Copra Drying and Copra Dryers, 1950. Price 1s. 6d.

Applications should be made to the Librarian, Department of Agriculture, Suva, Fiji.

—EDITOR



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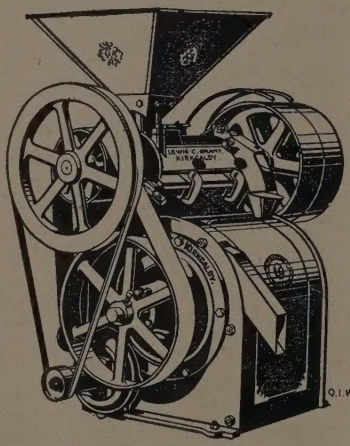
ISSUED BY THE DEPARTMENT OF AGRICULTURE, FIJI.

PLANTERS MILLS
BY GRANTEX
For Edible Rice in one Operation

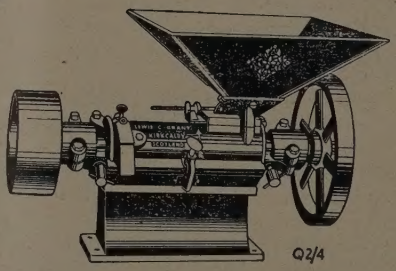


No. 1 RICE HULLER

Output of cleaned Rice per hour from Paddy	500- 650 lb
Output of cleaned Rice per hour from Shelled Rice	1000-1300 lb
Driving pulley	12½" x 5"
Speed Revs. per minute	600- 750
Power required, B.H.P.	15
Approximate gross weight	700 lb
Extra weight if fitted with fast and loose pulleys	95 lb
Extra weight if suction fan fitted	50 lb
Approximate shipping measurement	30 cu. ft.
Output of cleaned Rice per hour from Paddy	80- 100 lb

No. 4 RICE HULLER

Output of cleaned Rice per hour from Shelled Rice	160- 200 lb
Driving pulley	8" x 3"
Speed Rvs. per minute	750- 900
Power required, B.H.P.	4
Approximate gross weight with low stand	180 lb
Approximate gross weight with high stand	210 lb
Extra weight for fast and loose pulleys	30 lb
Approximate shipping measurement	30 cu. ft.



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JUBILEE MESSAGE FROM HIS EXCELLENCY THE GOVERNOR

This year is the fiftieth anniversary of the founding of a Department of Agriculture in Fiji and this Number completes the 25th Volume of the Fiji Agricultural Journal. On the occasion of these two historial events I am very glad to contribute a few thoughts on the state and prospects of our agricultural industry.

During the past fifty years the world has experienced a period of change greater than that of the previous five hundred years. One of the most important aspects of this change has been the recognition that the soil is an inheritance which, with proper treatment, can be made to become increasingly productive, but if used with neglect and ignorance, will deteriorate until it becomes useless. The extent to which this principle has been accepted varies throughout the world. In many places subsistence farming by primitive methods still prevails and the inhabitants of those areas are thereby confined to a bare subistence standard of living which, for the majority, will only improve if the land on which they exist is made more productive. This can only be achieved by the acceptance of scientific farming through which yields can be increased to such an extent that not only do farmers of small holdings have ample food for their own purposes, but they are able to produce surpluses for sale, and thereby acquire the purchasing power to obtain a variety of amenities associated with civilized living, as well as the mechanized equipment, fertilizers and those other essentials to good farming practices which enable them to produce still more with less physical effort.

We in Fiji have had little occasion to relate agricultural production with the attainment of a reasonable standard of living because we are fortunate to enjoy a climate and soil which appears to be able to produce good subsistence crops with the minimum of human effort and interference. It would be unwise, however, to rely indefinitely upon the generosity of nature without paying tribute to her and respecting her idiosyncrasies: Mother Earth, like all female creation, turns sour with neglect.

There are several reasons why we should pay tribute to our soil now and continue to do so in the future, but I will confine my remarks to the three which I consider to be the most important. Firstly it may be assumed that our population will increase substantially. While in a sparsely populated land the soil can survive abuse through being left fallow to recuperate, when pressure of population demands that it should render maximum production without interruption, this primitive method of retaining fertility cannot be adopted. Of course all land, even when heavily fertilized, benefits by a rest from producing the same crop but, at the risk of encroaching on the preserves of the specialists, I venture to suggest that this does not mean that it should not be producing some crop all the time, or several crops at the same time, provided what one crop takes from the land is replaced by what another puts back. I hold strongly to the view that the development of agriculture in Fiji, where the reserves of land

are restricted, should be on the intensive system by which a small farm, through producing a variety of crops and livestock concurrently, can be highly lucrative while, by proper rotation and usage, retaining the fertility of the soil. Another advantage of a mixed farm is that the farmer is protected against a weakening in demand for a particular crop; the old adage about not having all your eggs in one basket applies to farmers as well as to everyone else.

Secondly we live in an age of rising standards of living. One often hears remarks to the effect that this or that should be done; that everyone should have proper housing, piped water supplies, good schools, and such domestic conveniences as sewing machines, pressure cookers and refrigerators. It is right that all should enjoy the products of modern industry but these, perhaps fortunately, cannot be distributed on a basis of charity and those who wish to enjoy them must see to it that their own productive effort is sufficiently remunerative to enable them to purchase what they want or feel they should have. In an agrarian community such as Fiji this involves, for the majority, a proper use being made of the land.

Finally we have our obligations as one of a community of nations to ensure that we make the best use of the natural resources at our disposal to enable us to contribute our share towards the welfare of humanity. It is especially important that we should fulfil these obligations by making proper use of our land so that we can contribute towards the world's food supplies at a time when the pressure of population in some countries obliges appreciable numbers to exist on the borders of starvation.

When I speak of paying tribute to the soil, I mean by good husbandry, the use of fertilizers and compost, proper rotations and the prevention of soil erosion and waste, returning the fertility which is taken from it so that its condition improves and it becomes more productive, not only for this generation, but for the others which will follow. But here I really am on specialist ground and I shall leave it to the Department of Agriculture to explain and demonstrate the various processes which constitute good and constructive farming. An important medium through which it imparts this information is through the pages of this Journal which, in conclusion, I commend to the farmers of Fiji in the sure knowledge that, if its advice is heeded, it will be to their and the Colony's advantage.

R. H. GARVEY,
Governor.

Government House,
1st January, 1955.

AGRONOMY . . .

FIJIAN AGRICULTURE—CAKAUDROVE, 1953

This report deals with statistics collected by the field staff during the second quarter 1953 *and is here summarized by districts.*

ACREAGE PLANTED TO ROOT CROPS BY FIJIANS.

District	No. of Koros	A/B Males	Dalo	Yams	Tapioca	Kawai	Banana & Vudi	Dalo-ni Tana	Kumala	Total
Savu Savu ..	20	327	57·0	....	61·2	....	33·7	....	....	151·9
C'drove (m/l)..	6	63	20·0	4·2	25·2	1·2	4·4	....	·5	55·5
Tunuloa ..	14	233	64·7	16·2	73·4	1·3	....	....	4·2	159·8
Vaturova ..	15	152	68·0	61·0	67·5	35·7	57·5	....	....	289·7
Wailevu ..	11	209	59·0	53·8	57·5	2·2	6·0	....	....	178·5
Saqani . ..	23	235	54·2	67·0	72·2	24·8	39·2	·8	·2	258·4
	89	1,237	322·9	202·2	357·0	65·2	140·8	·8	4·9	1,093·8

The District of Laucala and the part of Cakaudrove District on Taveuni is not included in the above summary.

Savu Savu District—All the Koro in this district with the exception of Viani, Drekeniwai and Viviti have adequate food crop supplies. The overall average acreage planted to crops per able-bodied man is ·46 acres whilst the average per able-bodied man for the above mentioned villages is ·17, ·22, and ·27 acres respectively.

Cakaudrove—The average planted per able bodied man is ·88 acres of root crops. There are adequate food supplies in the mainland villages.

Tunuloa—The only koro in this district that are short of supplies are Natewa, Vusasivo, Tukavesi and Buca. The Natewa villagers have stated that wild pig damages in gardens is severe. The average per able bodied man is ·69 acres and the average planted per man for the above four koros is ·52, ·53, ·59 and ·54 respectively.

Vaturova—From the figures supplied this district is " well off " as far as food is concerned the average planted per able bodied man is 1·89 acres. The district has plenty of food land for root crops.

Total plantings of 30·5 acres of bananas were also recorded.

Wailevu—This district has ample land for crops. The average planted per man is ·85 acres. There are seven villages that were not recorded.

Saqani—The average planted per able bodied man here is 1·0 acres and the only village that seems to have insufficient root crops is Yasawai—near Udu point: the reason being inadequate land for planting.

The following summary shows the figures of Fijian owned livestock:

District	Cattle		Horses		Pigs		Total
	Total	Under 6 month	Total	Under 6 month	Total	Under 6 month	
Savu Savu	32	6	69	9	18	11	117
Cakaudrove M/L	....	....	2	....	3	2	5
Tunuloa			No	live	stock		
Vaturova	90	29	56	8	41	10	187
Wailevu	68	18	91	19	11	3	170
	190	53	216	36	73	26	479

The livestock figures for Saqani and Laucala are not yet auailable.

BANANA PLANTING—WAILEVU DISTRICT.

The Banana planting in this district took place in February. The project was brought up at the district council when it was announced that banana buying was to start at Savusavu so it was decided that every able bodied man plant 50 suckers per year. By the end of March 3,386 had been planted —figures taken from 11 of the 19 koros in the area.

—L. HARMAN.

FIJIAN AGRICULTURE—WESTERN DIVISION, 1954

On Malake island, Ra, 450 varas from the nurseries were planted out in four blocks during May, under direction of the Field Assistant.

Field staff, at the request of the Roko, supervized the planting of one acre of bananas at Nailaga and arranged for a further four acres to be prepared for planting at the end of the year.

At a tikina council in Yasawa the Field Assistant commented on the prevalent lack of care in the drying of copra and stressed the need for improvement. The six koros inspected produced a total of 140 tons of copra for the six months January to June. During this period approximately 10,000 coconuts and 10,000 bananas were planted in Yasawa Tikina.

In Nadroga there is increasing interest being shown in the development of koro lands. Reports on proposals for planting at Druba and progress at Naveago have been forwarded during the quarter.

Planting at Naveyago by the end of June:

Potatoes .. .. 4 acres
Bananas .. .. 2 acres
Tobacco .. .. 1 acre.

with 12 acres ready for maize and kumala.

At a rough estimate there are 1,000 acres of koro lands on the river flats between Naduri and Keiasi available for development.

—A.D.M.

CROP ROTATION IN THE DRY ZONE OF VITI LEVU

BY A. D. MERCER

The dry zone of Viti Levu comprises all the coastal areas of Ba Province together with parts of the Provinces of Ra and Nadroga, and within this area a well defined dry season is experienced from June to November or December. Practically all the first class land is devoted to the growing of sugar cane but outside these areas, the main crop is rice, grown as a subsistence crop. Yields from these areas are declining, and some attention to sounder farming practices is required to arrest this trend.

Rice growing by cane farmers for home consumption is on a basis of fairly sound husbandry. The land is of high natural fertility, receives periodic dressings of lime, phosphate and nitrogen, with an occasional crop of Mauritius bean as green manure. The rice crop is rotated on different areas of cane fallow, and under this sytem yields are good, and soil fertility maintained.

On the less ferile soils outside the cane areas, no systematic rotation is practised. The holdings are small, and the needs of the average family require every acre of ploughable land to be sown to rice every wet season for home consumption, with, in some cases, a surplus for sale in a good season. The rice stubble is commonly grazed by cattle during the dry season, but if the rice harvest is sufficiently early and soil moisture adequate, a legume crop of pigeon pea, cowpea, mungh or urid may be sown in May or June, but this practice is not extensive. In considering a crop rotation for the dry zone it has to be borne in mind that these crops can be grown through the wet season only on the lighter soils of the slopes, and not in the pockets of heavier soils where rice is normally grown, unless solely for a bulk of green material to be ploughed in.

The main objectives of any possible rotation for rice land must be to maintain the supply of humus at a high level, and to secure control of Muraina grass (*Ischaemum rugosum*). There is no alternative cash crop to rice that will neet these requirements, as neither pulses nor roots will crop satisfactorily during the rice growing season. Cowpea or Mauritius bean would provide a large bulk of green material for ploughing in, and sown in alternate wet seasons, would maintain the requisite organic matter and at the same time suppress weed growth.

The soundest practice to maintain fertility would be a system of mixed farming under which half the arable area was under crop and half under grazing for alternate four year periods. On a holding with ten acres of arable land and twenty-five acres of hill grazing this would allow of five acres under rice each wet season, with four acres of pulse crops and one acre of roots and vegetables rotated over the area during the dry season for four years, when the area would again revert to grazing, and the other half of the ploughable land be brought under cultivation. Observations in the field indicate a marked response to phosphate by both rice and pulse crops. Stimulation of leguminous crops with applications of superphosphate, is the cheapest means of securing soil improvement, by root penetration, increased bulk of organic matter and additional nitrogen for the benefit of the following rice crop. Rational use of fertilizer in conjunction with a four year cycle of alternate cropping and grazing, together with soil conservation methods on the slopes, can halt the present decline in soil fertility and crop yields.

Unfortunately the number of farmers with a sufficiently large area of arable land to put this system into practice is very small. In the majority of cases the whole area available has to be sown to rice every season to meet the needs of the family. Records taken during 1953 from twenty peasant farms, possibly rather larger than the average, illustrate this point.

Total area of rice . .	128 acres
Padi consumed on farm .	612 sacks
Padi sold	104 sacks

The average acreage of rice on these farms is 6·4, whereas the average area per grower for the whole district is 3–4 acres. Since rice is the essential subsistence crop, and sixty per cent of the holdings have less than five acres of cropping land, it is apparent that the majority of farmers cannot apply a system of rotation on the holdings as at present constituted.

Conceding that the available rice land must be cropped every year, it is still possible, with some improvement on prevailing methods, to maintain both soil fertility and crop yields at satisfactory levels. Over half of the rice area is either drilled or broadcast, and no water additional to the wet season rainfall is provided. The lime and phosphate status of the soils must be maintained with coral sand and superphosphate applications, practices which a number of farmers are now adopting. Alternatives of land use during the dry season are—

(*a*) grazing the rice stubble by cattle;
(*b*) growing a legume crop.

Since the main object of treatment at this period must be to maintain a high level of organic matter for the rice crop, either alternative is quite reasonable, but is capable of improvement provided that the rice crop is harvested by May, and reasonable falls of rain dispensed up to August.

(*a*) The grazing capacity of the area, and consequently the supply of humus, could be substantially increased by sowing of a fodder crop on the rice stubble. Pasture grasses are too slow to establish, and a quick-growing bulky, soiling crop such as maize, grain sorghum or kavirondo sorghum is required.

(*b*) At present most pulse crops grown during the dry season are poor, mainly owing to inadequate cultivation and failure to achieve a good seed bed. Improvement in this respect, and the application of superphosphate, could ensure more vigorous and higher yielding legume crops, with a greater amount of plant residue for ploughing in.

These modifications of present methods, with early sowing of the rice crop to control Muraina grass, have some chance of acceptance among small farmers who cannot put into effect a wider rotational system.

CROP AREAS AND VALUES FOR THE PERIOD 1950-1952

PREPARED BY THE DEPARTMENT OF AGRICULTURE, FIJI

The attached table was prepared in order to assess:—

(*a*) The domestic value of agricultural produce, pastoral and stock products (i.e. meat, hides, etc.) produced in Fiji.

(*b*) The value of these items consumed in Fiji.

ACREAGES

The figures have been compiled from surveys undertaken each year by the staff of the Department of Agriculture.

YIELDS AND ESTIMATED CROPS

The yields quoted on the schedule are average yields for the whole of the Colony, no allowance being possible for abnormal conditions prevailing in any particular district.

ESTIMATED VALUE, ETC.

A high proportion of the items are subsistence crops. The totals including that proportion of each crop which has been consumed by growers.

GENERAL

Prices paid to growers and export values are not comparable because values are taken at different stages in distribution, and the tonnages exported have for this reason been expressed in terms of prices paid to growers.

The value of agricultural and pastoral items consumed within the Colony over the period 1950–1952 are estimated to be as follows:—

1950	.. ..	£4,093,465
1951	.. ..	4,661,231
1952	.. ..	5,270,679

RE, FIJI.

	ted Value o Growers		Value of Exports in Terms of Prices Paid to Growers		
	951 (10)	1952 (11)	1950 (12)	1951 (13)	1952 (14)
	£	£	£	£	£
Millet ..	670	707	....	....	....
Maize ..	4,800	4,800	....	....	....
Rice Padi .	094,800	1,125,000	....	....	....
Sorghum .	600	600	....	....	....
Beans ..	....	....	....	....	....
Pigeon Pea	18,209	16,554	....	....	....
Mung or Urd	13,440	14,560	....	....	....
Other Pulses	18,032	19,264	....	....	....
Potatoes ..	11,340	58,800	....	....	....
Potatoes (Sweet	81,000	86,400	....	....	....
Dalo ..	718,750	2,166,750	676	1,066	766
Tapioca ..	423,000	450,000	....	....	....
Arrowroot	....	....	....	....	....
Yams ..	627,600	669,760	....	....	....
Groundnuts	13,440	15,000	4,142	4,700	5,000
Sesame ..	....	....	....	....	....
Turmeric..	250	250	....	....	....
Carroway .	100	100	....	....	....
Mustard ..	....	....	....	....	....
Ginger ..	1,800	3,000	558	162	198
Tobacco ..	13,000	13,000	284	54	12
Yaqona ..	80,000	80,000	....	....	....
Coffee ..	2,000	1,000	....	....	....
Cocoa ..	....	....	....	....	....
Patwa (Fibre)	250	250	....	....	....
Miscellaneous Ve	....	....	....	....	....
Cabbage ..	6,660	7,400	....	....	....
Lettucc ..	30,240	32,480	....	....	....
Tomatoes .	45,360	47,040	....	....	....
Bananas ..	154,000	60,000	58,632	76,130	30,243
Citrus ..	....	....	....	....	....
Pineapple	56,000	80,000	20,000	20,000	30,000
Sugar cane	377,804	3,241,908	1,740,000	2,320,000	3,194,550
Coconuts and Co	333,475	2,540,400	1,780,125	2,193,466	2,387,976
Total Agri Product	126,560	10,735,023	3,604,417	4,615,578	5,648,745
Cattle Killed .	71,988	70,588	....	....	....
Pigs ..	10,835	11,635	....	....	....
Butter Fat	67,426	102,178	....	....	....
Hides ..	15,894	15,483	14,605	15,894	15,483
Goat and Sheep	86	94	54	96	94
	166,229	199,978	14,659	15,980	15,577

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type in Ra. It consists of a reddish grey clay topsail resting on a red or reddish yellow clay subsoil, on rock. The thicknesses of the horizons depend on their position; naturally on the steep slopes only skeletal soils are present, but the topsoil is never more than about six inches deep, and the subsoil about two to three inches. The topsoil structure is fine to very fine nutty, quite well developed. Salt influences are no doubt present on these soils too, but are not so obvious. The main vegetation is sparse trees and thick reeds. Little use is made of these soils.

Turning now to crops, coconuts grow well on the flat coralline soils behind the beaches. Undergrowth however is frequently thick, so many nuts must be lost. A considerable proportion of the husks seen where copra had been cut were of Vara (sprouted nuts). In some areas it was said that clearing had not been done since the 1952 hurricane, because this had stripped all the leaves off the palms and they were only now coming into full bearing again. No organized replanting was seen; natural replacement occurs through the growth of fallen nuts. Two legumes give considerable cover in sandy areas; they are the Beach pea (*Vigna marina*) and a very similar plant called *Uru* by the Fijians. The *Yaka* vine (*Pachyrizus trilobus*) is also a common legume.

Breadfruit trees are plentiful throughout the village. The variety *Uto dina* is commonest; *Uto ni Samoa* and *Uto Boco* were also seen. There is little citrus, although a shaddock in the village was fruiting well, despite marked chlorosis.

Bananas grown on the colluvial soil type in the south east corner in a protected valley looked healthy, with only a little scab and leafspot. Bunches however were small. There are a few mango trees which are said to fruit well. There is luxuriant growth of *Voivoi* (*Pandanus* sp.) used for making mats.

A considerable area of cassava is grown, on the opposite side of the hill to the bananas; the soil is again colluvial but is often steeply sloping. Burning the grass on the hill above the teitei aggravates the problem of soil erosion on the steep lower slopes. It was noticed that in one place about two inches of soil had been lost by erosion during the last rainfall. This was obvious, because of the small columns of soil about two inches high with stones on top covering them, which protruded from the general surface of the cassava garden under observation. Such severe erosion will almost certainly denude the slopes of soil altogether, or at least reduce the depth to a shallow equilibrium value, depending on the soil washing on to the place from above, and that washing away to below. Control measures should be introduced, especially keeping the soil covered with vegetation, and not permitting extensive areas to be cleared and dug at one time. Also it appears that there is little resting period and that repeated crops of cassava are taken from the same ground. Crops on flat land at the base of the hill were noticeably better than those on the hill slopes.

A few yams are grown with the tapioca, but no dalo or yaqona. Dalo and yams are grown on a small near-by island which also has good timber on it, since it is not repeatedly burnt.

There are no cattle and only a few pigs. The latter are kept in the usual type of small pen, the walls of which are made of vertical coconut-trunk posts.

A few wild plants have uses as famine foods; chief among these is Fijian arrowroot (*Yabia ni Viti—Tacca pinnatifida*) which grows quite thickly on the coralline soil under the coconuts. Two other plants whose roots also can be eaten are the creeper *Yaka* (*Pueraria thumbergiana*) and the bitter wild yam *Kaile* (*Dioscorea bulbifera*), which produces aerial tubers in the leaf axils.

In conclusion, it appears that there is little prospect of this isolated community growing more crops or keeping more stock (although they might reasonably try some poultry); but copra yields could undoubtedly be increased by better management, and unless better management is applied soon to the food gardens, soil erosion will seriously limit food production.

SAWDUST AND STRAW

BY N. S. MILES

The high prices of artificial fertilizers and the shortage of animal manures in overseas countries has led many farmers in countries like Canada, United States of America, and Australia to use cheaper and more easily available substitutes such as sawdust and straw. Both these vegetative by-products have been used in various ways to improve the soil with great success. Fiji, being an importer of artificial fertilizers, is largely dependent on the surplus produce of these overseas countries, and this variable supply plus the high cost has had the effect of limiting the use of fertilizers in the Colony's agricultural practices. The inevitable result has been deterioration and erosion of the soil, and in consequence low yields in crops.

Both sawdust and straw are in fair supply and are usually free. Cartage however is a relatively costly item especially in the former case. Both must be well rotted before ploughed into the ground or they will depress yields of the crop unless a nitrogenous fertilizer is applied when the crop is sown.

There are three ways in which these substitutes can be used:—

1. As a surface mulch and then ploughed in.
2. As a compost.
3. As a litter for poultry or pigs and used as a fertilizer finally.

1. The sawdust or straw is allowed to remain on the surface of the soil until it is well rotted. Here they will protect the soil from the direct action of raindrops and the suns rays thereby preventing surface run off in heavy rain, and the extreme drying off and cracking of the soil in a prolonged dry period. The ploughing in of fresh straw or sawdust will result in a depression of yields in the following crop as mentioned previously. This is due to the increase in the assimilation of soil nitrates by soil micro-organisms. The carbohydrate material contained in the straw or sawdust supplies the micro-organisms with food and energy thereby increasing their demand for available soil nitrogen. Hence the supply of soil nitrates to the plants is less, and yields are depressed. The ploughed-in material loosens heavy soils by improving structure and aeration, and increases the water holding capacity of sandy soils. A desirable depth of rotted material on the surface is one and one half inches. The ploughing in of sawdust presents no problems but straw usually necessitates the use of a disc plough.

2. The making of compost from straw is an expensive and time consuming process when compared with the manufacture from sawdust and the process is so widely known that it will not be discussed here. Sawdust compost is a slightly different process, and is much more easily manufactured. The sawdust must not be too dry when used. Sawdust and animal or poultry manure are mixed in the ratio by quantity of 3:1 and in order to prevent this becoming a breeding place for undesirable insects, including Rhinoceros beetle, the heap should be turned at monthly intervals and carefully examined for grubs. A heap of this kind is slow to decompose due to the action of antibiotics and acidity which inhibit the growth of cellulose decomposing bacteria. If animal or poultry manure is not available the sawdust can be used alone with the addition ot nitrochalk at a strength of one hundredweight per ton of sawdust. This acts as an activator.

3. Increasing importance is being paid overseas to the deep litter system of raising poultry and pigs. Not only do the animals and birds grow faster and keep better health, but the litter provides an excellent fertilizer eventually. It is customary to remove the litter after one year with poultry, and three to four months with pigs. The poultry litter creates no problems and so only pig litter will be discussed. Sawdust is better than straw as a pig litter as it does not get so wet and does not pack down into a hard mass. The system is started off with four to five inches of sawdust, and fresh sawdust and hydrated lime are added every two to three days to absorb excess mositure. It is essential that the litter be laid on a well drained floor and have a roof over it to protect it from rain. Rain water getting into

the litter will interfere with its decomposition. Fermentation of the litter will commence shortly after it has been laid and by the fifth week the litter becomes dark in colour, relatively dry, and crumbly. The addition of fresh sawdust or lime after this stage has been reached is only necessary if the litter becomes excessively damp. By the time the pigs are removed the litter has built up to a depth of two feet or more. This litter makes an excellent fertilizer and has cost nothing to produce.

The usual practice is to put the pigs on to the fresh litter at weaning and remove them when they have reached bacon weights. Fresh litter is put in before the next batch of pigs goes into the pen, some farmers leaving a little of the old litter in with it to speed up the fermentation process.

The uses and methods of using straw and sawdust have been discussed in some detail, and it is to be hoped that the success overseas farmers have had with these waste products will influence local farmers to make more use of them in improving their soil and subsequently their crop yields than they do at present. In the making of sawdust compost one must bear in mind that the heap provides the Rhinoceros beetle with an ideal breeding spot and adequate steps should be taken to prevent this.

BIOLOGICAL CONTROL OF NOXIOUS WEEDS

FIJI CONTRIBUTION

1. *Lantana*—The Fiji Government contributed £2,000 to a project for biological control of *Lantana* initiated by the Board of Commissioners of Agriculture and Forestry. During 1953 two entomologists searched in Mexico, Guatemala, Costa Rica, British Honduras and Trinidad, and forwarded a number of species of promising insects to Hawaii. Here they were bred, and feeding trials are being carried out on a list of useful plants supplied by the Fiji Department of Agriculture, to ensure that the insects will not attack economic plants. Having passed this test, the insects are certified safe for liberation. Recently the first colony of a leaf-rolling moth was received from Hawaii. This is now being bred in the insectary, preparatory to its liberation in the field. A number of shipments of *Lantana*—feeding insects should arrive during 1954.

2. *Other weeds*—In 1951 the Fiji Government made available a sum of £1,000 for preliminary investigations into biological control of weeds, to be carried out by the Commonwealth Institute of Biological Control in Trinidad. Lantana, Guava and Tobacco Weed had first priority, and Solanum, Nutgrass, Tar Weed, Hibiscus Burr, Mint Weed and Blue Rat's Tail second priority. A list of economic plants was provided, on which promising insects were to be tested.

The Institute has carried out some investigations, which to date have cost only £150. Recently it was reported that promising insects which attack Tobacco Weed and Blue Rat's Tail have been found. The Institute has been requested to go ahead with work on these insects.

3. *Noogoora Burr*—The seedflies which were introduced from Queensland several years ago to control Noogoora Burr have not since been recovered in the field. Field collections of burrs are made from time to time, in the hope that the seedfly may yet be found to have established itself.

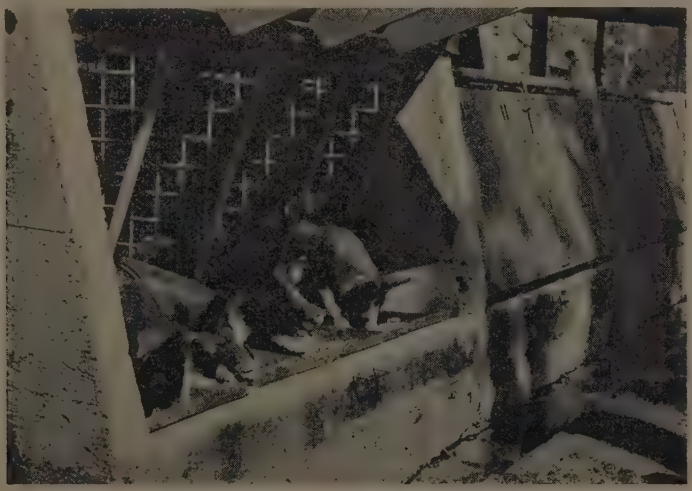
ANIMAL HUSBANDRY . . .

PIG FEEDING TRIALS

THE RELATIVE VALUE AND ECONOMY OF ANIMAL, PLANT, AND A MIXTURE OF ANIMAL AND PLANT PROTEIN FEEDS IN THE RATION OF FATTENING PORKERS IN FIJI

BY W. J. A. PAYNE, R. K. NAIDU AND V. E. SILLS

There are sixteen individual feeding pens in the piggery at Sigatoka constructed of tubular steel and heavy gauge steel mesh, with a pivoted wooden door carrying the through partition, closing the front. The pivoted door would not normally be open while the pigs are feeding.



Feeding pen showing pivoted doors open.

A major factor limiting pig production in Fiji is the absence of adequate supplies of suitable local feeds, particularly animal protein feeds. Consequently the production of porkers for the meat trade in the past has been almost entirely restricted to dairy farms with supplies of skim milk, or butchers with meat offals. Supplies of skim milk are limited and are likely to decrease as milk is diverted from butter making to the more profitable liquid milk market, and butcher's offals are only available at a few centres, there being no local manufacture of meat and bone meal.

There is a growing local demand for all types of meat including pork, so that although the production of porkers has increased, the importation of pig products has increased still more rapidly. Pig producers can only meet this demand if they are assured of a supply of suitable feeds, especially protein feeds. The only protein feeds available at present, apart from local supplies of skim or buttermilk and butchers offals, are a small quantity of meatmeal imported under licence from New Zealand or Australia, unlimited supplies of relatively expensive dried skim or buttermilk imported

from New Zealand and Australia, a large supply of locally manufactured coconut meal, and very small quantities of other locally produ ed plant protein concentrates such as peanut meal.

Thus the pig producer who has no skim milk or butcher's offals has to make up rations using (*a*) relatively expensive imported animal protein concentrates, (*b*) cheaper locally produced plant protein concentrates, or (*c*) has to search for and develop new local sources of animal protein. This is a difficult choice as it is well known that pigs, at least up to 90–100 lb liveweight, do not grow as rapidly on a ration containing only plant proteins as they do on one containing some animal protein.

This series of trials has been designed to assist the local pig producer to solve some of these problems. The first trial described in this paper is designed to investigate the growth of porkers on rations containing animal, plant, and mixed animal and plant protein feeds. A search is being made for new local sources of animal protein or for supplements to the existing plant protein feeds, and the use of these to replace expensive imported animal protein feeds will be investigated in subsequent trials.

EXPERIMENTAL METHODS

Sixteen crossbred Tamworth x Berkshire, twelve barrows and four gilts, were used in the experiment. They were selected from four litters born at approximately the same time, and were arranged in four groups of four according to weight and sex. One pig from each group was then placed at random on one of four feeding treatments. The treatments were high animal protein, low animal protein, high mixed animal and plant protein, and high plant protein. The pigs were housed in two adjacent sties, each with eight individual feeding pens. The environment of each group was very similar.

On October 23rd, 1953, the pigs were weaned and allocated to their groups. Experimental feeding could not begin until December and for six weeks all the pigs were fed on a plant protein ration (Table 1).

When experimental feeding began the pigs were fed meal ration type A to 70 pounds liveweight and then meal ration type B until slaughter weight at 120 pounds (Table 2).

TABLE 1

RATION FED TO EXPERIMENTAL PIGS 23RD OCTOBER TO 3RD DECEMBER, 1953.

Feed	*Parts*
Maize meal	40
Peanut meal	20
Coconut meal	40

Plus standard station mineral mixture.

TABLE 2

EXPERIMENTAL RATIONS FED TO PIGS

Feed	I. High Animal Protein	II Low Animal Protein	III High Mixed Protein	IV High Plant Protein
Ration A fed until the pigs weighed 70 lb				
Molasses ..	5	5	5	5
Maize meal ..	70	80	60	70
Peanut meal ..	....	....	....	15
Coconut meal ..	....	....	20	10
Meat meal ..	20	10	10	....
Dried buttermilk powder .	5	5	5	....
	100	100	100	100
S.E.	57·9	61·1	55·8	57·9
P.E.	13·4	10·7	13·1	13·0
Nutritive ratio .	1: 4·3	1: 5·7	1: 4·3	1: 4·4
C.P. % according to analysis ..	17·0	12·4	14·5	14·4
Ration B fed after the pigs weighed 70 lb				
Molasses ..	10	10	10	10
Maize meal ..	60	70	55	60
Peanut meal .	....	....	....	10
Coconut meal ..	....	....	10	5
Rice bran ..	15	15	15	15
Meat meal .	10	5	5	....
Dried buttermilk powder .	5	....	5	....
	100	100	100	100
S.E. .. .	56·0	58·3	55·0	55·6
P.E. .. .	10·5	7·8	10·3	10·5
Nutritive ratio .	1: 5·4	1: 7·4	1: 5·3	1: 5·3
C.P. % according to analysis ..	14·4	9·9	13·3	12·4

All rations also contained the standard station complete mineral mixture.

All four treatment groups were fed according to the following routine.

7.30 a.m. ..	Half meal ration
11.00 a.m. ..	Molasses ration
1.00 p.m. ..	Greenfeed ration
3.00 p.m. ..	Half meal ration

The meal was dry and fed *ad lib.* It was weighed in and out of the troughs morning and evening. The molasses was fed separately in a special tray to facilitate weighing, it was weighed out daily but only weighed back weekly. The greenfeed, which was always chaffed elephant grass, was weighed in and out of the troughs daily. Molasses and greenfeed were not fed *ad lib.* but according to the scale in Table 3.

TABLE 3

AMOUNT OF MOLASSES AND GREENFEED FED

30–50	2	0·13
50–70	3	0·19
70–90	4	0·25
90	5	0·31

All four type A and type B rations were analysed for crude protein at the beginning of the experiment.

The pigs were weighed daily, a health record was kept and after each treatment group had passed 120 pound liveweight the pigs were slaughtered and the hot carcasses weighed.

RESULTS

There were remarkable differences in growth rate between the pigs fed a ration containing plant protein only and those fed rations containing animal protein (Table 4 and Diagram 1).

TABLE 4

LIVEWEIGHT GAIN OF PIGS ON THE FOUR DIFFERENT RATIONS

Weight of pig lb	Weight of greenfeed lb		Weight of Molasses lb	
	I High Animal Prot.	II Low Animal Prot.	III High Mixed Prot.	IV High Plant Prot.
Av. weight (lb) beginning experiment 4th December, 1953 ..	42·3	45·0	47·5	39·0
Av. daily gain (lb) 4·12 to 120 lb liveweight	1·26	1·05	1·34	0·73
Av. daily gain % of Group IV	172	143	183	100
No. days from 4·12 to 120 lb liveweight .	62	72	54	111
No. days from birth to 120 lb liveweight .	158	168	158	207

The differences in growth rate between the pigs in Group IV and Groups I, II, and III were statistically significant ($p=0·05$), as were the differences in growth rate between the pigs in Group III and Group II ($p=0·5$). Thus it can be said that those fed a high level of plant and animal protein grew best of all, followed by those fed a high level of animal protein only. Lowering the level of protein feeding from 17·0–14·4 per cent to 12·4–9·9 per cent significantly reduced the rate of growth, so that under Sigatoka conditions ration II was not quite an adequate ration for optimal growth. The growth rates of pigs on rations I and III were very good and well up to the standard of pigs fed similar rations in the temperate zone.

There were remarkable differences in the time taken from the beginning of the experiment to reach 120 pounds liveweight. The time taken by Groups I, II, and III was significantly shorter than the time taken by group IV ($p=0·01$). In fact group III pigs reached 120 pounds liveweight in less than half the time taken by group IV pigs.

These differences were reflected in the time taken to grow from birth to 120 pounds liveweight, despite the fact that all the animals were on a plant protein ration until the beginning of the experiment.

The amount of food consumed, together with the meal consumption per pound liveweight gain and the cost of meal per pound liveweight gain are shown in Table 5.

TABLE 5

TOTAL FEED INTAKE AND MEAL CONSUMPTION AND COST PER POUND LIVEWEIGHT GAIN.

	I High animal prot.	II Low animal prot.	III High Mixed prot.	IV High Plant prot.
Type A meal (lb) ..	81·3	88·7	81·2	74·6
Type B meal (lb) ..	149·0	172·3	153·4	211·4
Total meal (lb) ..	230·3	261·0	234·6	286·0
Molasses (lb) . ..	2·6	4·2	3·8	2·0
Greenfeed (lb) ..	34·8	35·9	25·2	98·3
Meal consumption per lb liveweight gain (lb)	2·95	3·48	3·25	3·55
Cost of meal per lb liveweight gain (pence) ..	12·7	13·9	13·1	12·0

The meal consumption per pound liveweight gain was low in all groups by temperate zone standards. Group I pigs showed the lowest meal consumption per pound liveweight gain but none of the differences between the treatment groups were significant. It is interesting that the consumption of molasses by all treatment groups was low though the individual variation in consumption was high. In ordinary farming practice molasses would not be fed alone but mixed with the meal rations. The consumption of green feed was lowest in the fastest growing pigs (Group III) and highest in the slowest growing (Group IV). It would seem that pigs that are fed on rations containing protein solely of plant origin require a plentiful supply of greenfeed. The differences between the treatment groups in the cost of meal per pound of liveweight gain were small, but the cost of meal for the slowest growing group was the cheapest. The cost per pound of the different rations fed are shown in Table 6.

TABLE 6

COST IN PENCE PER POUND OF THE EXPERIMENTAL RATIONS

	I High animal prot.	II Low animal prot.	III High mixed prot.	IV High plant prot.
Ration A fed until pigs weighed 70 lb	4·71	4·71	4·35	3·73
Ration B fed after the pigs weighed 70 lb	4·05	3·61	3·86	3·25

It was not possible to slaughter all the pigs at 120 pounds liveweight owing to the difficulty of getting the butcher to take them on the exact day. Consequently the average weight at slaughter of the treatment groups was well above 120 pounds liveweight. The average weights at slaughter and the killing percentages are shown in Table 7.

TABLE 7

AVERAGE WEIGHT AT SLAUGHTER AND KILLING PERCENTAGE

	I High animal prot.	II Low animal prot.	III High mixed prot.	IV High plant prot.
Average weight at slaughter (lb) ..	138	150	137	136
Average killing percentage	80·3	77·2	81·3	75·5

After allowing for differences in the average weight at slaughter it is obvious that the fastest growing pigs killed out best.

DISCUSSION

Recent research has shown that the feeding value of animal protein feeds lies not only in their basic amino-acid structure, but also in the fact that they are a source of "animal protein factor". This is the name given to a complex of many unidentified accessory food factors found in or associated with protein rich feeds of animal origin and certain biosynthetic products produced by micro-organisms. In feeding practice A.P.F. is more necessary to the piglet and to the pregnant and lactating animal than it is to the fattening animal. Nevertheless plant protein feeds are not generally as useful as animal protein feeds for fattening purposes.

The type of meal rations fed in Fiji can be compared with the type of rations fed in Great Britain, so that British experience can be used as a guide by the pig fattener in Fiji. Prior to 1939 it was normal in Britain to advocate the feeding of rations containing 20 per cent animal protein, but wartime experience and post war research have shown that these amounts are excessive and not essential. Where barley, bran, minerals and grass meal are fed, 7 per cent fish meal or 2 per cent fish meal and 6 per cent peanut meal, or 20 per cent peanut meal (Woodman and Evans, 1948, 1951), or 15 per cent soya bean meal (Evans 1952), are sufficient protein supplements to meet the full need of fattening pigs between weaning and 90 pounds liveweight. After 90 pounds liveweight no animal protein supplement need

be provided as long as the total protein content does not fall below 12·5 per cent (Woodman and Evans, 1951).

Only a small amount of peanut meal and no soyabean meal is available in Fiji. The most plentiful plant protein feed available is coconut meal, with which little overseas experiment feeding work has been done. Fish meal is not available and has to be replaced by meat meal and skim milk or buttermilk powder. Fish meal is superior as a protein feed to meat meal (Carpenter 1951), so that it is probable that in Fiji we would have to use slightly higher quantities of meat meal than the percentages of fish meal quoted for the British rations.

Using British experience as a guide it would seem that the high plant protein ration IV would not give maximum growth, and that the animal protein ration II might be deficient in total protein, but that the high animal protein ration I and the high mixed protein ration III would be satisfactory. This is what happened in practice.

In assessing the relative value of the four rations, the unit cost of rations I, II, and III was greater than that of IV, so that despite very much faster growth rates on rations I, II, and III the cost per pound of liveweight gain was least in the case of the high plant protein ration IV. The killing percentage however of the pigs fed ration IV was considerably less than that of the pigs fed rations I and III and the cost of producing a unit pound of pork was least in the case of the pigs fed rations I and III. The feeding of rations I and III also had other advantages, as the pigs were only in the fattening pens for half the time taken by those fed ration IV, so that the cost of labour was approximately half and the pen rental per pig was less. This means that the feeding of rations of the type of experimental rations I and III would increase the output of the piggery and allow the farmer to keep more breeding pigs per unit of pen space.

If the farmer was only keeping a small number of breeding pigs and was paid for his pigs on a liveweight basis, it would probably be more economic to feed a plant protein ration such as ration IV, but if he is a large scale producer or sells by dead weight it would be economic to use the relatively expensive imported animal protein feeds and make up rations similar to rations I and III.

Unfortunately meat meal is not freely available in Fiji, so that full advantage cannot be taken of these findings, and it is important to make every effort to find alternative local sources of animal protein feeds.

It is of some interest to note that when pigs are kept under relatively good management conditions and fed optimal rations, their rate of growth and ability to economise in the conversion of feed into pork are as good in the tropics as in the temperate zone.

SUMMARY

1. A replicated feeding experiment using sixteen crossbred Tamworth x Berkshire barrows and gilts has been completed.

2. The objects of the trial were (*a*) to obtain information on growth and economy of feed conversion when fattening pigs under good management are fed optimal rations, (*b*) to compare the growth under local environmental conditions of fatteners fed rations using animal, plant, and mixed animal plant protein feeds with approximately the same protein equivalent.

3. The pigs were individually fed and raised to approximately 120 pounds liveweight, when they were slaughtered and hot carcass weights obtained.

4. The growth rate and economy of gain of the pigs fed optimal rations were very good by temperate zone standards.

5. The groups fed animal (I) or mixed animal and plant protein feeds (III) grew significantly faster, and occupied the pens for approximately half the period taken by the group fed plant protein (IV). Meal consumption per pound liveweight gain was lowest and killing percentage was highest in groups I and III.

6. The unit cost of the plant protein ration (IV) was lowest as was the cost of meal per pound liveweight gain.

7. When all factors are taken into consideration it would obviously be economic for the large scale pig producer selling his pigs on a deadweight basis to use imported animal protein feeds such as meat meal and dried buttermilk powder, if and when these feeds are freely available.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance of the Acting Deputy Director of Agriculture, Mr. A. F. S. Ohman and the Acting Senior Veterinary Officer, Mr. K. J. Garnett who arranged for and carried out some of the hot carcass weighings and certain body measurements.

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The following article replaces the " Agricultural Advisers Report " as shown in the index to this issue.

THE HARVESTING AND GRADING OF PEANUTS FOR EXPORT

Harvesting.—Harvesting should in preference be undertaken during bright weather when the soil is not too wet, the plants being generally mature when the following signs become apparent :—

(1) The foliage becomes yellowish or dull green losing its bright fresh green colour ;

(2) the veins on the inside of the pods become dark in colour.

The insides of the shells should have lost their " fluffiness " while the kernels should be full and firm, crisp to the bite but without that milkiness apparent in the immature nut.

The weather can however be such as to maintain the leaves in their bright fresh condition and it is therefore advisable to examine the plants after 4 to 4½ months' growth to ascertain whether the nuts are mature.

When left in the ground even a few days after maturity, the vines are likely to become detached from the roots and the nuts liable to germinate ; on the other hand the nuts will shrivel and become valueless if harvested too soon.

Curing.—The practice of stripping the pods from the vines and drying them in the sun immediately after harvest causes the kernels to shrivel and for this reason, curing of the crop is recommended.

When the plants have been dug, they should be shaken to remove any soil adhering to the pods and then dried in the sun for a few hours to wilt the leaves. The plants should then be arranged in small circular stacks with the pods on the inside and the foliage on the outside, each stack being capped with a layer of weeds as protection against the rain and supported down the centre by a pole driven into the ground.

The plants may remain in the stocks for a period of from 14 to 28 days, the duration of the period being dependant on the prevailing weather conditions. The nuts must be dry and the pods shatter easily before the curing process can be considered completed.

Storage.—Peanuts must not be stored until they are thoroughly dry otherwise the kernels are liable to shrivel and become mildewed. It is also advisable to keep the crop in the shell for as long a period as possible as shelled nuts are more susceptible to insect infestation.

Grading.—Peanuts whether shelled or in shell should be carefully graded before export : Those intended for export in the shell should be fully mature, dry, clean and free from any trace of damage, discoloration or mildew, while the kernels should be of a clean sound edible condition, showing no signs of mildew, decay or disease.

All consignments are examined by an Inspector of Produce with power to reject any sub-standard stock.

FISH FARMING

BY W. J. A. PAYNE, R. K. NAIDU, V. E. SILLS AND S. V. HOLMES*

This is a brief account of a small scale fish farming project at Sigatoka Agricultural Station, which was conceived as part of a systematic search for a local and economic source of animal protein for pig feeding. The ideas incorporated in it are not original, but follow normal practice in South East Asia, and the project was initiated with the advice and assistance of the Director of Fisheries, Malaya.

THE SIGATOKA PROJECT

During October 1953 a pond half a square chain in area and two to four feet deep was excavated on a site adjacent to the Station piggery, using a small bulldozer and a farm grader." As the area was being redeveloped it was possible to incorporate the pond in the piggery area with the minimum trouble. The total cost was £14. The pond was filled with water in December 1953 and an aquatic plant *Ipomoea reptans* was established in it by throwing some runners on to the surface of the water. These soon attached themselves to the sides and started to grow.

Fifty-two *Tilapia mossambica* fingerlings were air-freighted from Malaya. They arrived in good condition and were all alive when placed in the pond on the 28th of January, 1954. Early in February effluent from the piggery sump was run into the pond, and a simple sluice was made so that the amount of effluent running in could be controlled. (Plate 1.) Within a few days the pond water became a deep pea-green colour as the algae and phytoplankton multiplied. The *Ipomoea reptans* began to grow very rapidly and within three weeks it almost covered the whole pond. (Plate 2.) On the 28th of February a dead *Tilapia* some five inches long was found floating on the surface presumably bitten by an eel. An eel was then seen and it was confirmed that one predator had already established itself in the pond.

On the 29th of March the pond was found to be swarming with the fry of *Tilapia mossambica*. A net was dragged through and one large fish, three fingerlings and a number of fry were removed. It was evident that after only two months the *Tilapia* had grown from two inch fingerlings to adult fish, the largest of which were seven to nine inches long, and that they had already reproduced (Plate 3). On the 6th of April the first cut of *Ipomoea reptans* began and some nine hundred pounds of wet material were removed during April. On the 8th of April four adult fish were netted and placed in an iron tank. A large number of fry were observed in the tank one month later.

The drainage system of the Sigatoka station piggeries. All effluent enters the sump shown in the foreground and the liquid part then flows down the channel into the fish pond, shown in the background. Solid material is taken out at intervals and placed in the midden (out of the picture). *Photo R. R. Wright.* [Plate 1]

* Senior Nutritionist, South Pacific Health Service.

TABLE I

CHEMICAL ANALYSIS OF *IPOMEA REPTANS*
(On dry matter basis.)

	Per cent dry matter	Per cent crude protein	Per cent crude fibre	Per cent crude fat	Per cent total ash	Per cent n-free extractive
Leaves and shoots	9·2	34·3	10·2	3·9	12·9	38·7
Whole plant	6·9*	19·6	20·4	3·4	15·5	41·1

* The percentage dry matter content of the whole plant is lower than that of the shoots because the stalk is hollow and full of water.

On the 3rd May fifty-two fingerlings were removed from the pond for sale and at the same time two Yavula (*Megalops cyprinoides*) were caught in the nets. This is a common Fijian carniverous fish so that within four months of the pond being filled a second predatory species had somehow effected entry.

To sum up, it can be said that the fish *Tilapia mossambica* has been successfully introduced from Malaya, that it grows with great rapidity in the fishpond at Sigatoka, and that two months after arrival in the Colony it has reproduced.

The aquatic plant *Ipomoea reptans* (Plate 4) also grows luxuriantly on the pond and has every indication of yielding large amounts of greenfeed per annum, though investigations will have to be made as to the most satisfactory method of harvesting (Plate 5). The tips of *Ipomoea* are very palatable and make an excellent substitute for spinach, and the whole plant is eaten with relish by cattle and pigs. It was found that the pigs eat it so greedily that they tend to "scour" and it is now fed mixed with elephant grass (*Pennisetum purpureum*), and this has proved to be an excellent greenfeed mixture. Chemical analyses show that it is a fodder plant of exceptional value and is comparable in feeding value to red clover or lucerne (Table 1).

The fish pond showing the luxurious growth of *Ipomoea reptans* on the surface of the pond. (*Photo R. R. Wright*) [Plate 2]

THE GROWTH OF TILAPIA MOSSAMBICA AT SIGATOKA
(Approximately ⅓ natural size.)

1. Fingerlings introduced 28/1/54 from Malaya. [Plate 3]
2. A single fish caught one month later on 28/2/54.
3. A single fish caught two months later on 29/3/54.
4. Young fish hatched at Sigatoka within two months of the introduction of fingerlings: caught 29/3/54. (*Photo R. R. Wright*)

Within two or three years it should be possible to establish what yields per acre of *Tilapia* and *Ipomoea* can be expected under Sigatoka conditions. Little is yet known as to the difficulties that may be encountered. Two predatory species have already been found in the pond, the eel and "Yavula", and it is obvious that ponds will have to be constructed so that they can be drained and the predatory species removed or destroyed. There are large numbers of toads (*Bufo marinus*) in the pond and it is not known whether they or their tadpoles eat the fish eggs or the small fry. This is a problem that will have to be investigated. During heavy rain this season some storm water entered the pond and appeared to reduce seriously the algae and phytoplankton population, so that further precautions to stop the entry of storm water will have to be taken in the future. It is not yet known whether the pond will retain its water throughout a prolonged dry season such as was experienced in 1953. As a precaution a concrete tank is being built in which the breeding fish can be kept. Nothing is yet known as to what quantity of piggery effluent should be run into the pond. At present it is only run in intermittently, in an effort to keep the pond water a deep pea green colour in appearance.

Malayan experience suggests that when the plant *Ipomoea* is grown on the surface of the pond it will utilize all the excess fertilizers. There have been no troubles with mosquito larva, and it is assumed that the large toad population keeps the mosquito under control.

MALAYAN EXPERIENCE OF *TILAPIA MOSSAMBICA CULTURE*

Tilapia mossambica is an African fish that was introduced into Malaya from Java by the Japanese. It is extremely hardy and adaptable, able to exist in fresh or salt water, but not able to tolerate temperatures below 40°F. It grows rapidly and reproduces at an early age, the best growth rates

recorded being in brackish water ponds on Singapore Island, where fish weighing thirty ounces at one year old have been captured.

It is not known what is the most economical size of pond, but rectangular ponds are the most practical, though every advantage should be taken of natural contours. A suitable size for a breeding pond is a square chain, but fattening ponds are usually larger and may be one acre or more in extent.

Malayan ponds usually contain 2½ to 3 feet of water, and where the soil is sandy the sides of the ponds are boarded up. The pond should be provided with a sluice gate so that it can be emptied for cleaning, liming, or catching fish. Water should not be allowed to run through the pond, it is best if the water in the pond stagnates, and flood water should not be allowed to run in.

The water in the pond should be neutral or alkaline in reaction and if it is not, lime should be added. When the pH of the water is 6·4–6·7 two tons of burnt lime per acre is added. This should be done when the pond in emptied, as this has the added advantage of killing predatory species. Two days after liming the pond should be filled with water and if no effluent runs into the pond cow or pig manure added at the rate of eight tons of wet dung per acre of three feet deep water. After fourteen days the pond will be a deep green colour, showing that it is ready for stocking with fish.

It is usual to stock for fattening purposes with two inch fingerlings at the rate of 1,000 fish per square chain, though the optimal stocking rates have not yet been determined. The growth is rapid up to six inches in length, then it slows down. *Tilapia* can be sexually mature when they are four inches long so that it is desirable to thin out the fish when they are four to six inches long. Chinese fish farmers in Malaya cull out all fish when they are five inches in length and this has been found to give optimal yields. Experimental ponds of the Malayan Department of Fisheries have yielded 1,065 pounds per acre annually, and one Chinese fish farmer with twenty-five acres of ponds has obtained a steady yield of 800 pounds per acre per annum.

If no effluent or organic manures are available to encourage the growth of algae and phytoplankton, *Tilapia* will eat and thrive on rice bran, coconut meal, and chopped tapioca leaves, as although it is essentially an algae and phytoplankton feeder it can eat other vegetative matter.

THE POSSIBILITIES OF FISH FARMING IN FIJI

The advantages of fish farming are quite clear. The production per acre of animal protein is appreciably larger than with any other form of farming. Fish farming makes the most efficient use of fertilizers and in the absence of total drought, all the year round production is assured. It also requires less capital to lay out fish farms than conventional farms on low lying swampy ground.

The major disadvantages are that only a relatively small area of the country is suitable for fish farming, that large quantities of water are required, limiting its utility to

Ipomoea reptans: **the young shoots are used as a human food and the remainder as a pig or cattle feed.** (*Photo R. R. Wright*) [Plate 4]

the wet tropics, and that it is a more specialized occupation than pastoralism and that labour costs are undoubtedly higher.

As was stated in the introduction, the Sigatoka project was conceived as part of a systematic search for animal protein feeds for pig production. It might not seem sound economics to feed fish to produce pork, as pork is only two to three times the price of fish, but only a relatively small part of the pig ration would consist of fish. If Malayan yields can be obtained in Fiji one acre of fish pond will produce annually sufficient animal protein in the form of fish to provide suitable rations for twenty pork pigs raised from birth to 120 pounds liveweight. In addition it will produce a large quantity of vegetables for human consumption and fodder for dairy cattle and pigs. If pig, fish, fruit and vegetable production can be combined it may prove both practicable and profitable (Fig. 1).

Successful fish farming for pig production might eventually lead to fish farming for human consumption. The logical extension of the Sigatoka project would be to produce fish from the ponds for human consumption, fillet them on the spot, and feed the fish offals back to the pigs. With these considerations in mind certain cooking tests on *Tilapia* have been made.

THE POSSIBLE USE OF *TILAPIA MOSSAMBICA* AS HUMAN FOOD

In appearance these fish are darkish grey with a lighter belly. The skin is scaly and there are a few spikes in the fins. The scales are easily removed leaving a thin skin which is suitable for cooking with the fish. Approximately 50 per cent of the whole undressed weight consists of edible flesh. On cooking, the skin and head become soft and gelatinous. The flesh is brownish on the surface and white throughout. It is medium grained, fairly firm and moist and lifts off the bone in a fillet. The flavour is good and the texture quite tender. Fijians, Indians, and Europeans tasted the cooked fish in a test and considered it quite an acceptable food.

Harvesting *Ipomoea reptans* by rolling it up over the surface of the pond. It can be seen that the pond is very shallow. (*Photo R. R. Wright*) [Plate 5]

It appears that *Tilapia* would be an asset to the diet of all sections of the population in Fiji. Small fish with sweet flesh and gelatinous skin and head are a popular food throughout the Colony.

It would not be necessary to restrict fish farming for human consumption to the use of *Tilapia mossambica*, as many other species that are now cultured in South East Asia could be introduced, and fish farming might become a profitable secondary industry where there are large scale piggeries, in a dairy area such as Tailevu, or at large school or other institutions that have a farm.

Tilapia fingerlings are available for sale to the general public. Price £5 per hundred. Application should be made to the Director of Agriculture, Suva, or to the Officer-in-Charge, Sigatoka Agricultural Station.

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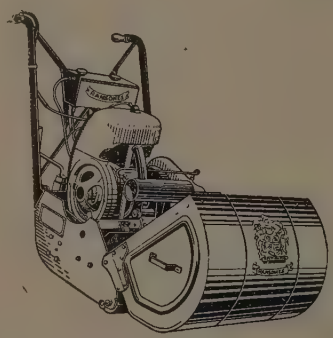

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DEHORNING OF CATTLE

BY N. S. MILES

Although the loss suffered by cattle owners in Fiji due to horn damage is probably no higher than that experienced by farmers in countries where types of stock and climatic conditions are similar, the fact that these countries are attempting to reduce their losses by dehorning cattle suggests that their example could profitably be followed here.

The campaign for dehorning cattle has gained momentum in recent years. In some cases it has been assisted by Government legislation, e.g. in Canada, where a fine is levied on any farmer selling horned stock in a sale yard. The increased popularity of dehorned stock, as seen from the greater number of dehorned exhibits in Agricultural Shows overseas, has influenced some Pure Breed Societies to draw up new score cards so that dehorned exhibits are at no disadvantage to their horned competitors.

There are two main contributory factors to financial loss due to horn damage in Fiji and they are:—

(A) The breeding practices of most farmers are poor. Cows and heifers are often mated to the nearest bull regardless of breed or type, or are turned out onto the hill grazings to be mated to any of the semi-wild bulls that are to be found there. The infusion of Zebu blood though advantageous in some respects has the disadvantage that it tends to produce a more nervous type of animal which must receive more handling to offset this trait.

(B) There is a reluctance on the part of many farmers to erect fences or yards so that some control and handling can be exercised over their cattle. Where they are erected they are often inadequate, consisting of one strand of barbed wire and small posts at intervals of one chain or more. It is difficult under these conditions to keep stock docile and the result is that at some stage or other a number of them are horned.

Breeding and management of stock if controlled can reduce losses due to horning to a minimum, but the systematic dehorning of all cattle may eliminate it altogether, and it is felt that the latter method would give quicker results with less effort than the former.

The advantage of dehorning cattle may be summarized as follows:—

(*a*) It reduces the incidence of mastitis in dairy cattle, and the amount of marked hides and bruised meat in beef cattle.

(*b*) It eliminates the danger of damage to the farmer himself.

(*c*) The stock are more docile, are more easily handled, and there seldom is a "bully" in the herd. The cattle can safely be fed from a trough or rack.

(*d*) The yard or carriage space required per beast is smaller. This is of importance when laying down concrete yards in dairies, and where freight costs from farm to slaughter house are high.

Various methods of dehorning have been devised and the adoption of any one of them will depend on the type of management employed by the farmer. Generally speaking dehorning can be carried out at any age. The methods used in each age group are:—

(1) Calves at 5–8 days, when the horn buds can be felt under the skin—(*a*) Caustic potash in pencil or paste form. This is the most commonly used agent. The hair is clipped away from the base of the horn and vaseline is smeared on the exposed skin. The horn bud is rubbed lightly with sandpaper to remove the hard outer covering. The caustic pencil, protected by several layers of paper, is then rubbed in a circular motion on the bud till it bleeds slightly. After treating a few calves and noting how the potash is acting, one will be able to judge the amount of rubbing necessary to make a success of the operation. After treatment calves must be prevented from sucking one another and kept out of the rain for some days.

(*b*) Antimony trichloride in collodian, and silver nitrate. Their application is similar to that of Caustic potash.

(*c*) Hot Iron. The pointed end of a soldering iron is removed and a section of copper tubing with an inside diameter of 9/16 inches is brazed on in its place. The iron is either heated by fire or electric current to the required heat and then applied to the horn bud.

(2) *Calves 2–3 months old*—On station properties where calves mustered are of varying ages as in Argentine, a simple and efficient method is used. The instrument resembles a large carpenter's gauge with a wooden handle, and curved blade with a very keen cutting edge. this is applied to the base of the horn and given a smart tap with a mallet. The horn is effectively removed and the resultant small wound is treated with Stockholm tar.

(3) *Yearlings*—The horns are removed by an instrument called a guillotine. This is a double-bladed instrument, the blades having a very keen cutting edge, coming together in the shape of a diamond. The horn is cut off cleanly at the base. If the operation is carried out correctly there is no regrowth of the horn. There is some bleeding but provided the operation is performed when flies are not troublesome a scab will soon form and the animal will not be set back unduly. Stockholm tar can be applied to the wound.

(4) *Adult stock*—At this stage the removal of the horns is an extremely painful process and one that is forbidden by law in many countries unless the animal is anaesthetized. Horn treatment should be restricted to tipping. This is the removal of up to to $\frac{1}{3}$ of the horn, which at the extremity is hard and solid and does not contain the nerves and blood vessels that render it so sensitive an organ in the area near the head.

The resons for, the advantages of, and the methods of dehorning have been presented. It rests with the individual farmer to select the method best suited to his management practices.

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REPORT ON THE POSSIBILITY OF USING "TILAPIA MOSSAMBICA" AS HUMAN FOOD

BY SUSAN HOLMES*

The fingerlings of the fish "Tilapia Mossambiea" were introduced to a pond at Sigatoka agricultural station in February 1954. *They grew and reproduced rapidly. During the period of four months three generations have appeared in the pond and the original fish are now* 4–5 *inches long.*

During the recent visit four fish, weighing 57–98 grams were caught and prepared for cooking.

APPEARANCE

The fish are darkish grey with a lighter belly. The skin is scaly and the fins have a few spikes.

PREPARATION

The scales are easily removed and the remaining skin is thin and suitable for cooking with the fish.

The viscera is small, the larger proportion being liver. In one spawning the fish spawn comprised half the weight of the viscera, the total weight being twice that of non-spawning fish of the same size.

The fish were weighed whole. The percentage edible portion was calculated for three fish by subtracting the weight of head, viscera, scales and fins, and bones from the cooked fish from the total whole weight.

Total Raw Weight grams ..	98·2	58·7	57·1
Percent edible portion ..	45·42	49·91	51·25
Available protein grams per fish	7·29	4·95	4·24

The refuse amounted to approximately 50 per cent of the whole fish which compares favourably with waste from average sized fishes in other parts of the world.

Three fish were cooked by the steaming method and one was fried.

APPEARANCE OF COOKED FISH

The skin is soft and palatable. The flesh below the skin is brownish on the surface and white throughout. The flesh is medium grained, fairly firm and moist. When cooked it lifts off the bone in a fillet. The flavour is mild and the texture quite tender.

There is a relatively small amount of bone and the flesh comes off this easily.

The cooked head has a gelatinous appearance and is quite palatable.

One fish was fried and this was equally acceptable.

It was agreed by those present that this fish might be classed as "good" from the point of view of flavour and texture. Fijian and Indian assistants on the farm consider the fish a very acceptable food.

POSSIBILITY AS A SOURCE OF FOOD

It is considered that this fish would be an asset to the diet of all sections of the community in Fiji. Small fish with sweet flesh and gelatinous skin and head are a popular food with the Fijian and Indian populations. It is doubtful whether there would be any objection to the fertilization of the pond with manure. In reality, very little manure is used in the Sigatoka pond, and the nitrogenous material needed for the growth of the fish food (algae and *Ipomea reptans*) in the pond could be provided from artificial sources.

Fish pond farming is a very suitable way of producing food for institutions in Fiji. The advantages are—

(1) Fish provides an important source of animal protein (average daily costs per head for recommended daily rations of fish and meat vary between 8d. to 10d.)

(2) The *Tilapia Mossambica* appear to thrive in Fiji and increase at such a rapid rate that ponds could supply significant amounts of fish for feeding large institutions.

(3) The *Ipomea reptans* which grows in the pond provides an excellent green vegetable of exceptionally high food value. The leaves have twice the protein content of greens such as cabbage and this makes them a valuable food for humans and animals (present daily cost of a recommended ration of green vegetable is 2d. per head).

(4) The management of the pond requires very little labour or supervision.

(5) The harvesting of greens is simple. Suitable methods for catching the fish are being developed by the Agricultural Station.

(6) The wastage from the fish and *Ipomea reptans* may be fed to pigs.

* Senior Nutritionist, South Pacific Health Service.

WEED CONTROL . . .

MINT WEED—TIMOCI NI VAVALAGI (HYPTIS PECTINATA (L.) POIT.)

Mint weed occurs over a wide area of Fiji. It is a declared secondary noxious weed in the Provinces of Tailevu, Naitasiri, Rewa, Serua and Nadroga–Navosa of Viti Levu and a primary noxious weed throughout the other Provinces of the Colony. It is an erect shrub up to ten or twelve feet in height, green in colour, with soft angular stems and serrated leaves. Owing to its prolific seeding and rapid development the plant tends to form a dense cover which smothers the grasses and other vegetation. The weed appears to have no value as a fodder.

BOTANICAL DESCRIPTION.

Hyptis pectinata (Linn.) Poit. Family: Labiatae (*Nepeta pectinata* Linn.; *Hyptis pectinata* Poit; *Mesosphaerum pectinatum* Kuntze; *Ballota parviflora* Sesse.)

Common Names: Mint Weed; Timoci ni Vavalagi.

An erect, coarsely herbaceous plant, 4 to 12 feet (60–420 cm.) high with densely puberulent, angular stems. Leaves ovate $\frac{3}{4}$ to 3 inches (2–8 cm.) long and $\frac{1}{2}$ to 1 inch (1·25 to 2·5 cm.) wide, serrate, dark green and slightly puberulent on the upper surface, pale and densely puberulent on the lower surface, apex acute, base usually subcordate. Flowers subsessile in cyme-like clusters on an axis to form a long spike-like inflorescence. Calyx $\frac{1}{16}$ to $\frac{1}{8}$ inch (2 to 4 mm.) long, puberulent with straight awl-shaped lobes almost as long as the tube. Corolla very light purple in colour and slightly longer than the calyx. Seed oblong, fairly smooth and black, less than $\frac{1}{32}$ inch (1 mm.) long.

The seeds of *Hyptis perctinata* are distributed by becoming attached to the coats of animals, to the clothes of man or by being carried in the mud on the feet of animals.

The first published description of *Hyptis pectinata* was one prepared by Linnaeus (*Nepeta pectinata* Linn.) which appeared in 1759. The species is a native from Mexico to Brazil but it is now widespread in waste and cultivated land in many parts of the tropics, including Africa, where it is very common. There are no records to indicate how or when this plant was introduced to Fiji.

CONTROL.

Mint weed is highly susceptible to hormone type herbicides during all stages of growth.

The following rates of application have been found to give satisfactory control.

2, 4,—Dichlorophenoxyacetic acid—
Rate of application: 1 in 480.
Seedlings: 1 in 1000.

2, 4, 5,—Trichlorophenoxyacetic acid—
Rate of application: 1 in 480.
Seedlings: 1 in 1000.

2 methyl—4 Chlorophenoxyacetic acid—
Rate of application: 1 in 480
Seedlings: 1 in 1000.

5 per cent M.C.P.A. dust—
Rate of application: 40–60 lb.
Seedlings: 10–15 lb.

The hormone type herbicides can be applied directly to mint weed without any preparations. The best results are obtained when the spraying is carried out during fine weather. However satisfactory results can be obtained during dull, overcast weather if the spraying is carried out not less than three or four hours before rain, but if sodium or amine salts are used a longer period before rain is required. A second and possibly a third spraying will be necessary to control the dense seedling growth which will develop.

All areas of infestation should be kept under observation for some time and fresh plants destroyed as soon as possible. Care should be taken to prevent the weed from seeding.

T.L.M. & J.W.P.

REFERENCE:
Degener, O.—" Flora Hawaiiensis."

MINT WEED. *Hyptis pectinata* **(Linn). Poit). declared noxious weed. (a) Habit x $\frac{1}{3}$; (b) Stem showing leaves and hollow stem x 1; (c) Portion of flowering spike x 1.**

WATER HYACINTH—BEKABEKAIRAGA (EICHHORNIA CRASSIPES, SOLMS.)

Water hyacinth is a declared noxious weed throughout the whole Colony. The species is a recognized pest of waterways, lakes and drains.

BOTANICAL DESCRIPTION.

Eichhornia crassipes Solms. Family: Pontederiaceae. (*E. speciosa* Kunth; *E. crassicaulis* Schlecht; *Pontederia azurea* Sw.)

Common Names: Water Hyacinth, Bekabekairaga.

A floating plant, herbaceous, roots having a calyptrate covering at the extremity. Stems very short, the leaves almost entirely emersed, roundish but very variable in shape; petioles long or short, more or less inflated below the middle, with a sheathing scale at the base. Scape from 6 to 12 inches (15 to 35 cm.) long with several sheathing bracts. Flowers 6 to 12, tube curved, glandular, pubescent outside near the base, pale purple or mauve in colour; the five lower segments nearly equal, the upper one larger and marked with yellow spot on a mauve background. Stamens inserted within the tube, 3 long, 3 short; anthers oblong. Ovary tapering up into the style, stigma capitate. Seeds small, ovoid, with numerous ribs.

E. crassipes is a native of South America and of tropical Africa. It is now found in many tropical countries where it is often a serious pest in waterways. In the southern part of the United States of America, it is a very serious pest of waterways and is known, consequently, as the "million dollar weed."

CONTROL.

Many millions of pounds have been spent, by the tropical countries of the world, on the control of this weed but it was not until the advent of hormone type herbicides that any real progress was made. The weed is susceptible to a wide range of these herbicides the following of which has been extensively used for its control in the Rewa River Channels with satisfactory results.

2, 4,—Dichlorophenoxyacetic acid, Butoxythanol ester—

Rate of application: 1 in 250.

Mixture for knapsack sprayers—2 fluid oz. in 3 gallons of water.

To obtain the best results spraying should be carried out while the plants are still young and before flowering commences. It is important that the spraying should be carried out during fine weather and that the plants should be thoroughly wetted. Very low volume applications should only be used where plants are not protected by other weeds and grasses.

T.L.M. & J.W.P.

REFERENCES:

Bailey, F. Manson.—"The Weeds and Suspected Poisonous Plants of Queensland."
Bailey, F. Manson.—"The Queensland Flora."
Robbins, Craft & Raynor.—"Weed Control."

THE COCONUT MOTH IN FIJI

A few copies of the classical work by J. D. Tothill, T. H. C. Taylor and R. W. Paine, published in 1930 by the Imperial Institute are available for sale. These are slightly weather stained but otherwise in good condition.

The book describes the successful work on biological control of the Coconut pest *Levuana iridescens* carried out during the period 1925–1930 and is well illustrated.

Price £1. Orders to Director of Agriculture, Suva.

Water Hyachinth (*Eichhornia crassipes* Solms). Declared noxious weed. Habit study.

ENTOMOLOGY . . .

THE RHINOCEROS BEETLE (ORYCTES RHINOCEROS L.)

NOTES ON THE CONTROL CAMPAIGN IN FIJI

BY B. A. O'CONNOR

In an earlier article in this Journal(1) *an account was given of the discovery of the Rhinoceros Beetle in Fiji, its distribution in the Colony, and the measures being taken for its control. The following notes describe the situation as it is at present* (*July* 1954).

DISTRIBUTION

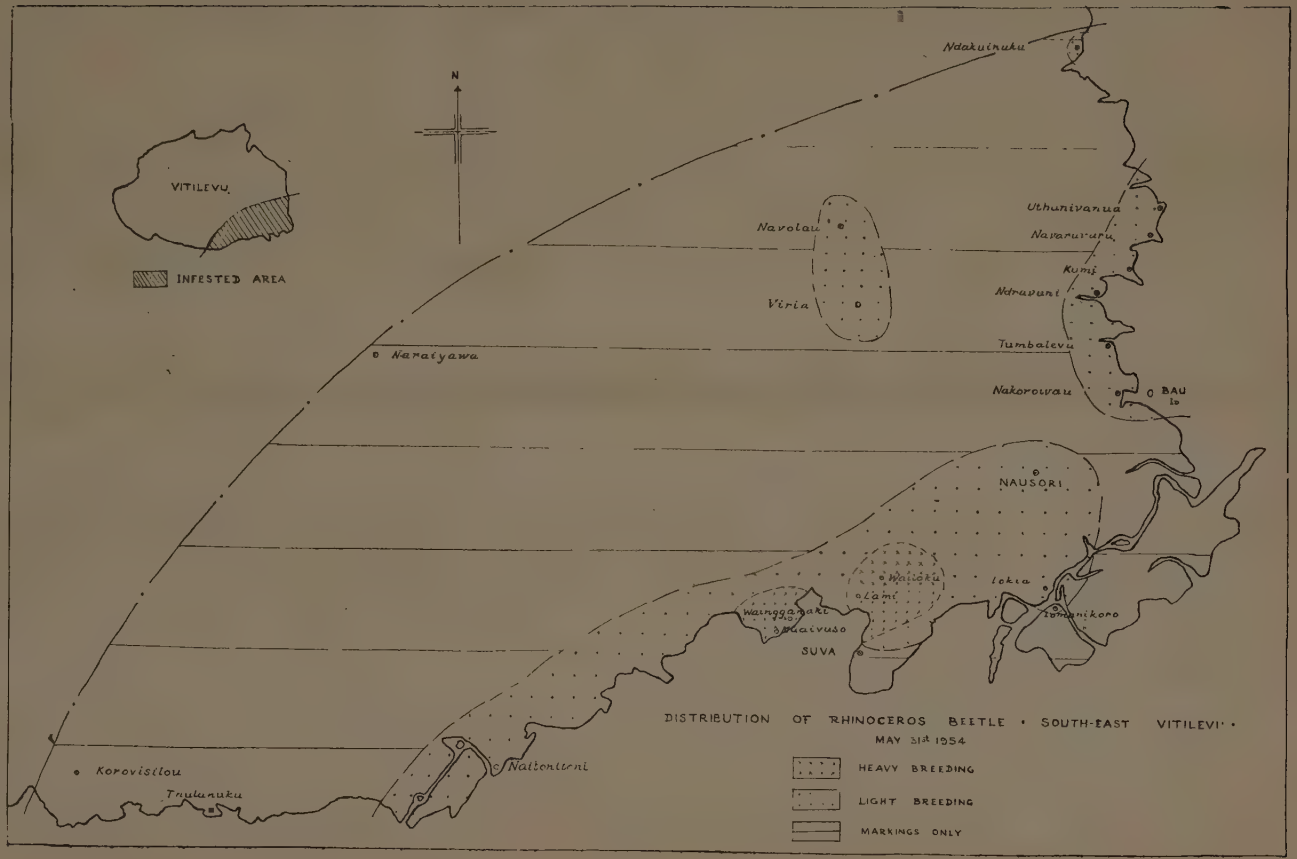
1. The sketch map shows the known distribution of the beetle, which has increased since the publication of the previous article. Breeding has been found at Viria and Navolau, on the Rewa River, and along a narrow strip of the eastern coast of Viti Levu, and the limits of the original infested south coastal strip have been extended somewhat east and north-east. A single beetle has been found at Dravuni, and a marked palm at Naluwai, near Vunidawa. (Fig. 1)

ARTIFICIAL CONTROL

2. (*a*) *Collections and destruction of breeding places*—Gangs are continually employed on the searching and destruction of likely breeding places, and they receive considerable assistance from village people. Since the beginning of September 1953, all palms in areas where breeding or marked palms have been found have been climbed and searched. The total catch during the sixteen months since the campaign began has been about 250 eggs, 2,500 larvæ, 90 pupæ and 525 adults (300 males, 225 females). About 80 per cent of the total has come from the two small areas marked "heavy breeding" on the sketch map.

(*b*) *Compost traps*—Experience with compost traps consisting of pits 2 feet 6 inches square and 1 ft. 6 in. deep, filled with damp sawdust, to which was added 12 pounds of finely ground coconut meal, with B.H.C. and water, indicated that decay proceeded much more slowly than had been the case when the mixture was used in drums in the experimental cage. The quantity of coconut meal was increased to 24 pounds without any marked improvement. The trap now in use is a pit 1 ft. 3 in. square and 2 ft. deep, containing a mixture of damp sawdust, 24 pounds coconut meal, ½ pound B.H.C. 50 per cent dispersible powder (6·5 per cent gamma isomer) and four to 5 gallons of water. The mixture is poured loosely into the pit, without pressing it down, as ample æration appears to be required to produce quick decay. The proportion of dry coconut meal to sawdust is approximately 1 to 2 by volume. After addition of the water, the meal swells to the same volume as the sawdust. The material in the pit subsides considerably after rotting. The present practice is to make up the mixture in bulk, for filling of holes already prepared. About 100 traps per week are laid down. It should be stated that this work has been carried out with a finely ground type of coconut meal: coarser products have not been experimented with.

A test of the residual effect of the B.H.C. in compost traps has been made. Material was taken from one of the older-type compost mixtures containing one pound of 50 per cent B.H.C. dispersible powder (6.5 per cent gamma isomer) in ten cubic feet of compost. (In the type of trap at present in use, the concentration of B.H.C. is 50 per cent greater). The material was abstracted from one of the drums which had been used in cage experiments 7½ months earlier and had since been kept in the open. It was placed in a wire gauze container, pieces of sugarcane were supplied as food, and five male and five female beetles were introduced. These were left in the mixture for four days, after which four male and two


VITILEVU
INFESTED AREA
N
Ndakuinuku
Navotau
Viria
Uthunivanua
Navaruvaru
Kumi
Ndravuni
Tumbalevu
Nakorotvau
BAU
Naraiyawa
NAUSORI
Waicaka
Lami
Ioka
Tomanikoro
Wainggamaki
Waivuso
SUVA
Korovisilou
Tavuvuku
Nattonitoni
DISTRIBUTION OF RHINOCEROS BEETLE • SOUTH-EAST VITILEVU •
MAY 31st 1954
HEAVY BREEDING
LIGHT BREEDING
MARKINGS ONLY

female beetles were found dead. The male and three females which survived were placed in untreated sawdust and were still alive eight days later. Thus the B.H.C. had considerable residual effect, and could be expected to inhibit the development of larvæ in the compost. (When the fresh compost mixture had been tested, ten beetles were left in the mixture for three days. Five days after removal from the mixture, all were dead).

(*c*) *Treatment of crowns of palms*—Mr. G. S. Dun, Senior Entomologist, Territory of Papua and New Guinea, advised(2) that he had obtained a good kill of adult beetles by placing D.D.T. powder in the axils of the leaves of oil palms. Later our attention was drawn to a statement in the 7th Annual Report of the Indian Central Coconut Committee(3) that experiments were being conducted with B.H.C. mixtures placed in the axils of the leaves of coconut palms. Preliminary tests in Fiji indicated that B.H.C. was more effective against the beetle than D.D.T., and definitely much more rapid in action. As it was desired to evolve a treatment which would kill the beetles before they could bore into the palm, B.H.C. was chosen for subsequent trials. Three formulations were used, namely a finely ground dispersible powder containing 6·5 per cent gamma isomer, a somewhat coarser dispersible powder containing 10 per cent gamma isomer, and powdered technical B.H.C., containing 13 per cent gamma isomer. Each of these formulations was mixed with damp sawdust at the rate of one part by volume to nine parts of sawdust. (This mixture was decided on after preliminary trials with more concentrated mixtures, and with fine sand as a carrier). The standard test was to place the mixtures in glass jars, put in a number of adult beetles, and after two hours remove the beetles to jars containing untreated damp sawdust, and keep them under observation. Controls consisted of beetles in jars of untreated sawdust. There was at no time any mortality in the controls. Though the results of the tests varied, it was found that each of the mixtures could kill 100 per cent of the beetles which had been exposed for two hours within from one to three days after exposure. When the mixtures were exposed to the weather for a fortnight, during which there was considerable heavy rain, in such a way that water could pass freely through them, there was very little leaching out of the insecticides. When beetles were placed in the leached mixtures for two hours kills of from 50 per cent to 75 per cent were obtained within three days after exposure.

A trial was then carried out with potted palms in a large outdoor cage. The fronds were cut short, to permit the palms, which were about four years old, to fit into the cage, which was 7 ft. 6 in. high. A mixture of the coarse B.H.C. dispersible powder (10 per cent gamma isomer) one part by volume in nine parts by volume of damp sawdust was placed in the axils of the youngest five fronds in one palm and the youngest four fronds in the other. A drum containing compost was placed in the cage, and at dusk eleven male and eight female beetles were placed on the compost. During the night, beetles were seen attempting to bore into the palms. They attacked in the axils which had been treated, appearing to prefer attacking in the space between the central spear of leaves and the youngest fronds, and evidently not being repelled by the B.H.C. The following morning, two male and four female beetles lay, badly affected by B.H.C., on the floor of the cage. The experiment lasted for five days, dead and affected beetles being regularly picked up from the floor of the cage, or taken from the axils of fronds, and kept under observation in damp sawdust. At the conclusion of the experiment, eight males and six females were dead, one male and one female were affected by B.H.C., (these died several days later) one male and one female were alive in the compost, and one living male was found in a channel about nine inches long, where it had bored into the central spear of leaves. This was the only beetle to gain entry to the palm tissue, though

LITERATURE CITED:

(1) O'Connor, B. A.—"The Rhinoceros Beetle (*Oryctes rhinoceros* L.) in Fiji". *Fiji Agric. Jour.*, Vol. 24, Nos. 1–2, pp. 35–46, 1953.

(2) Dun, G. S.—Private Communications 1953.

(3) Indian Central Coconut Committee, 7th Annual Report (April 1951–March 1952) p. 23. 1953.

there was some superficial chewing. The successful beetle possibly followed others which had pushed out fibre and disturbed the B.H.C. mixture. Of the deaths which occured, it was considered that only two (those of one male and one female) were due to natural causes. All the others were preceded by the characteristic tremors and paralysis caused by B.H.C.

Four and a half months after this trial had been conducted, during which time the potted palms had been exposed to the weather, some of the B.H.C. mixture was collected from the axils of the palms and its effect on adult beetles again tested. The mixture was placed in a glass jar into which beetles were introduced, left for a time, and then placed in untreated damp sawdust and kept under observation. All beetles which were left for 2½ hours in the mixture were dead after five days. Hence the B.H.C. mixture obviously has considerable residual effect.

The results of the tests with B.H.C. and sawdust mixtures appeared to justify treatment of the crowns of palms in the field. This has now become routine, a mixture of one part by volume of a B.H.C. formulation in nine parts of damp sawdust being placed in the axils of the youngest four or five fronds of every palm climbed. The two formulations which have been commonly used are the dispersible powders containing 6·5 per cent and 10 per cent gamma isomer respectively. Several thousand palms are now being treated weekly, and a few dead and dying beetles have been found in the axils of treated palms. Obviously protection of palms by this method could not be complete without the treatment of each new frond as it separates itself from the central spear. However, it is thought that our present practise should help materially in controlling the beetle. In countries where the pest is well established, crown treatment should be worth while for the protection of palms in their vulnerable first few years of life.

(*d*) *Treatment of sawdust heaps*—Sawdust accumulations at timber mills present a special problem. It is difficult to ensure safe disposal of the sawdust output without inflicting some hardship on the millers, yet considerable breeding has been found in the heaps. Experiments in inexpensive disposal of the sawdust by burning have been and are being carried out, and their results will determine whether or not regulations enforcing the burning of sawdust will be introduced. In the meantime, whenever a search for breeding is being carried out in a sawdust dump, the material searched is treated with B.H.C. spray to inhibit breeding.

(*e*) *Quarantine and Inspection*—In an effort to prevent the spread of *Oryctes* to other islands of the Fiji group, ships and small craft leaving the infested area are inspected. An inspector is permanently employed in the city of Suva, ensuring that possible breeding places are cleaned up. Touring inspectors keep a continual check throughout Viti Levu on the implementation of regulations regarding distruction of possible breeding places outside the known infested area, there are shipping inspectors stationed at Natovi and Lautoka. An effort has been made to inspect small craft departing from coastal villages, and arrangements are being made for this inspection to cover the southern and eastern coasts of Viti Levu from Naboutini to Viti Levu Bay.

3. *Biological Control*:—

(*a*) *Predatory beetles*:—

During February, 1954, a further 2,000 beetles of the genus *Leionota*, family *Histeridae*, were received from Mr. N. L. H. Krauss in Trinidad. These were liberated at Bilo and at 9 miles on the Queen's Road. Mr. H. W. Simmonds introduced from New Zealand a number of the *Carabid* beetle, *Mecodema* spinifer, for testing under cage conditions. Of these, 60 were liberated at 9 miles on the Queen's Road.

(*b*) *Scolia oryctophaga* Coq—As the numbers of Rhinoceros Beetles and their grubs are low in Fiji, and the distribution of the pest is restricted to a small area, conditions are not favourable for the establishment of parasites whose sole host in Fiji would be *Oryctes*. Nevertheless it was decided to make enquiries as to the possibility of importing the *Scoliid* wasps *Scolia ruficornis* from Zanzibar and *Scolia oryctophaga* from Mauritius. Reports from Zanzibar indicated that collecting of *S. ruficornis* would be expensive and would probably meet with

little success. Hence no further action regarding this species of wasp is contemplated for the time being. Advice from Mauritius was more encouraging. Mr. J. R. Williams, Entomologist, Department of Agriculture, Mauritius, kindly offered to collect and forward a consignment of about 500 female *Scolia oryctophaga* at very small cost. The wasps will arrive in Fiji probably in August, and will immediately be liberated in the infested area. *Scoliid* wasps are said to have a habit of killing considerable numbers of grubs by stinging, apart from those on which they lay eggs. Hence, even though *S. oryctophaga* may not become established in Fiji, the 500 females are capable of destroying considerable numbers of grubs.

(*c*) *Platymeris rhadamanthus*—Dr. F. L. Vanderplank(4) Entomologist, Coconut Pest Research, Zanzibar, has recently found that this large *Reduviid* bug preys on adult Rhinoceros Beetles. In a letter written in April, 1954, Dr. Vanderplank provided some information about this bug. It feeds on a variety of insects, and lives in the crown of the coconut palm, moving about and feeding at night. In captivity, a single bug can kill and feed on one adult Rhinoceros Beetle daily. It is considered that this bug could assist in controlling *Oryctes*, and might be of use against other insects which attack coconuts. Its introduction to Fiji is under consideration.

4. *Habits of Oryctes*—A point of interest regarding the beetle is that, though its population is very low in Fiji, there have been a number of occasions when several beetles have been found boring in one palm, situated among numerous other palms. In four palms of which records have been kept, climbers found 5, 7, 7 and 10 beetles during single searches, and on many other occasions more than one beetle has been found. It seems unlikely that such concentrations of beetles should occur by chance in individual palms. One possible explanation is that the fermenting sap in the tunnel bored by the first beetle attracts others.

More than 50 per cent of the grubs which have been collected were found in rotting logs, stumps and standing trunks and branches of palms and trees. The major portion of this 50 per cent came from coconut palms and Ivi trees (*Inocarpus edulis*). Standing dead or dying Ivi trees are a fruitful source of grubs. Many grubs have been found in sawdust heaps, and other breeding places included compost and refuse heaps, piles of grass clippings, the debris of old piles of firewood and even debris on a beach, just above high-water mark.

(4) Vanderplank, F. L.—Private communication, April 1954.

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NOTES ON THE COCONUT STICK INSECT, GRAEFFEA CROUANI LE GUILLOU

BY B. A. O'CONNOR, J. S. PILLAI AND S. R. SINGH

From time to time Coconut Stick Insect causes severe injury to coconut palms in Fiji, though normally the numbers of the pest are not sufficient to cause significant damage. Outbreaks are usually confined to comparatively small areas of up to 50 acres. The reasons for the rise and fall of populations of the insect are not known, though the influence of a local egg-parasite may be of importance. The insects devour the green tissue of the coconut leafets, and, where attack is most severe palms may be completely stripped of foliage and killed. One outbreak on the island of Taveuni caused the death of one hundred palms, and several hundred were killed during an outbreak on one of the Tongan islands.

During our studies of the insect, most of the life-history work has been carried out by Singh and Pillai, while O'Connor investigated the incubation period of the egg and conducted field observations, experiments in control measures, and breeding of the egg parasite. Much remains to be done, but it has been thought worthwhile to record our observations to date. As the insect does not reach pest proportions on the main island of Viti Levu, a full study would involve the stationing of an entomologist on one of the copra-producing islands. There is no prospect of doing this in the near future, but it is hoped that ultimately a detailed investigation can be carried out.

I—DESCRIPTION AND BIONOMICS

A brief description of the Stick Insect, and some notes on its host-plants, geographical distribution and life-history, have been given in an earlier number of this Journal(2). Following are some additional notes:—

Incubation Period—Eggs were kept in three different situations, to determine whether humidity affected incubation period or hatching. Results are shown in the following table:—

Number of eggs	Number hatched	Conditions under which eggs kept	Incubation period in days		Average temperature (approx.)
			Range	Average	
160	155	Saturated atmosphere	97–114	100	74° F
75	67	On sand, moistened at irregular intervals.	97–107	100	74° F
160	149	Air humidity	97–107	100	74° F
13	13	Air humidity	88–91	90	79° F

Hence atmospheric and soil humidity appear to have no significant effect on development and hatching of the eggs. The first three lots were observed during the cool season, when the average temperature was 74° F. and the fourth lot during the warm season, when the average temperature was 79° F.

Nymphs and Adults—The female has six nymphal instars and the male five. Duration of the male and female instars, preoviposition period of the female, longevity of adults and egg-production per female are shown in the table below. Figures for time

are in days, the first figure representing the average, and those in brackets the range. Females laid eggs at a fairly uniform rate throughout their adult life.

Sex	Duration of nymphal instars							Pre-oviposition period	Longevity of Adults	Egg production per female
	1	2	3	4	5	6	Totals			
Female	14 (13–16)	17 (14–20)	19 (17–21)	19 (14–22)	17 (11–20)	22 (21–25)	111 (106–113)	20 (19–20)	115 (104–127)	119 (106–131)
Male	15 (14–16)	21 (19–25)	19 (14–26)	21 (18–25)	18 (15–22)	....	92 (87–101)	....	167 (161–173)	....

Figures for the duration of the nymphal instars were obtained during the cool season. During the warm season the total nymphal period would probably average about 100 days for females and between 80 and 85 days for males.

II—CONTROL OF THE STICK INSECT

Two methods of control have been tried in field experiments, namely banding the trunks of palms with a tanglefoot mixture and using a power duster to apply insecticidal dust to the foliage. Results of both methods have so far been disappointing

Banding—The Stick Insects drop their eggs freely from their resting place on the palm-fronds, and most of the eggs fall to the ground. The nymphs which hatch from these then ascend the trunk of a neighbouring palm. Tanglefoot bands catch them, as well as some nymphs and adults which fall from the palms and attempt to climb up again. It was calculated that if the bands remained adhesive for a period of one year they could eliminate an infestation, provided that all eggs of the Stick Insect fall to the ground. The period of one year allows time for female nymphs which have ascended

Showing destruction to foliage and subsequent death of palms.

the palm just before application of the band to reach maturity and lay all their eggs, and for their eggs all to hatch. Experience in Fiji indicates that bands should remain sticky for twelve months if the surface is rubbed occasionally, and perhaps a little more tanglefoot added to thin spots.

A planter in Taveuni applied bands to a considerable area of palms which were infested by the Stick Insect, and when these were examined six months later the treated palms showed as much defoliation as the untreated, and similar populations of Stick Insects. The surfaces of the bands had not been rubbed, and young nymphs could pass over many of them. Nevertheless, it was surprising that no measure of control had been achieved. A climber was instructed to collect debris from the axils of the fronds of four palms, and when this was thoroughly examined twelve eggs of the Stick Insect were found, of which six had hatched. Thus it is evident that some of the eggs fall into the axils of the fronds, but it is not known whether the numbers of these are sufficient to produce a significant population of the pest. Two further plots of palms on the same plantation have now been treated with bands, which are to be rubbed from time to time. The bands applied on one plot have had BHC added to the banding material at the rate of one ounce of technical BHC (13 per cent gamma isomer) to one pound of tanglefoot.

Dusting—Laboratory tests indicated that BHC was very lethal to *Graeffea*, so it was decided to experiment with this insecticide in the field. Neither of the formulations used was intended specifically for dusting, one being a 50 per cent dispersible powder (6·5 per cent gamma isomer) and the other a 10 per cent dust (1·3 per cent gamma isomer) used mainly for soil treatment. However, the suppliers claimed that these formulations were suitable for powder dusting. The machine used was considered to be somewhat underpowered for treating very tall palms, though its performance was improved by adding lengths of aluminium piping to the outlet pipe. Finally, on the plantation where the dusting was carried out there was almost constant wind, and it was difficult to select a favourable hour when the wind had dropped. Five acres of palms were treated with each of the BHC preparations. Populations of stick insects in the plots were sampled before dusting and five days after dusting. In both plots a considerable number of stick insects were knocked down within two hours after dusting, many of them being dead or dying. The BHC 50 per cent dispersible powder was applied at 10 pounds per acre and the 10 per cent BHC dust at 40 pounds per acre. Mortality due to the 10 per cent dust was negligible, except on one palm which was given a massive application, and on which mortality approached 100 per cent. The 50 per cent dispersible powder caused mortality of 56 per cent, mainly nymphs.

These results were disappointing, but it is considered that BHC would be able to produce 100 per cent mortality if a suitable formulation were applied in such a way that the fronds received a uniform and adequate dosage. Further work is necessary on formulations and methods of application.

III—BIOLOGICAL CONTROL

Recently parasites have been bred from eggs collected in the axils of fronds of the coconut palm and on the ground on the islands of Taveuni and Vanua Levu. The parasite is a member of the family *Eupelmidæ*, and the Commonwealth Institute of Entomology reports that it probably belongs to a new genus, near *anastatus*.

A few observations have been made on on the life-history of the parasite. There is a great preponderance of females, hatchings from nine parasitized eggs collected in the field being as follows:—

2 m. 12 f., 2 m. 8 f., 3 m. 11 f., 1 m. 6 f., 2 m. 12 f., 1 m. 7 f., 2 m. 11 f., 1 m. 12 f., 8 f, a total of 14 males and 87 females. From six eggs which were parasitzed in the laboratory, emergences were: 1 m. 9 f., 4 m. 7 f., 2 m. 7 f., 2 m. 13 f., 3 m. 12 f., 9 m. It seems likely that the egg which produced males only was parasitized by an unfertilized female. Excluding this egg, we have a total of 12 males and 48 females from five eggs. The six parasitized eggs belonged to a lot of 20 eggs which had been placed in a tube with 1 male and 12 female *Eupelmids*, the remaining 14 eggs being unparasitized.

The 1 male and 12 female wasps mentioned above emerged from a field-collected *Graeffea* egg on June 16, and were placed in a tube with 20 *Græffea* eggs and honey and water mixture, in droplets on a piece of celluloid, as food. The female wasps immediately began oviposition. Of the 20 eggs used, 13 had been laid during the period May 13–22, and 7 during the period May 13–June 16. The parasites were all dead by June 20. On August 9, i.e. 50–54 days after ovi-position by the parasite, the operculum was removed from one egg, and the inner membrane broken. Immediately one male and nine female wasps, apparently quite healthy and normal, emerged, and mating began forthwith, as is the habit of the *Eupelmid*. Three days later, i.e. 53–57 days after parasitism, two more eggs were opened, and in each case healthy parasites emerged and mated. On August 15 and 17, i.e. 56–60 and 58–62 days after parasitism, healthy and active parasites emerged unaided from two eggs. Finally, on August 23, i.e. 64–68 days after parasitism, the last parasitized egg was dissected, and produced 9 large and healthy males.

It will be noted that the developmental period of the parasites which emerged normally on August 15 and 17 was two months, but that eggs dissected on August 9 and on August 23 each produced apparently normal and active parasites. This suggests the possibility that, under certain conditions, emergence of the parasites may be delayed or prevented. In this connection it should be noted that a few field-collected eggs, when dissected, contained dead adult parasites. Some preliminary trials have been conducted keeping one lot of parasitized eggs in a saturated atmosphere and another lot at air humidity, but there has been no significant difference in emergences. Further work along these lines is to be carried out.

The *Eupelmid*, with its high proportion of females and a developmental period much shorter than that of its host, might be expected to exert efficient control of the Stick Insect, and in fact the populations of the latter are low throughout the greater part of Fiji. However, in certain areas and at certain times, localized outbreaks of considerable severity occur. It seems possible that these outbreaks may be due to conditions unfavourable to the parasite. It is hoped that when adequate staff becomes available this aspect of the problem may be studied.

EXPORT OF ANIMALS, 1943-53

Listed are some of the animals exported from Fiji to various Pacific Territories. This list does not include dogs. Most of the exports have taken place in the last six years, but unfortunately records are not complete.

Territory	Cattles	Horses	Pigs	Goats	Poult.
Tahiti	42	..	..	..	1
Gilberts . ..	..	..	..	4	5
Tonga	3	..	5	..	..
Western Samoa	3	3	6	..	..
Eastern Samoa .	1	..	..	..	31
Fanning Island .	..	..	..	7	..
New Guinea ..	16	..	..	..	..
B.S.I.P... ..	56	..	9	37	99
Total ..	121	3	20	48	136

—K.J.G.

MARKETING . . .

QUARTERLY REPORT—MARKETING OFFICER

2ND QUARTER 1954

BY J. NIELD

Market reports on prices and on the availability of fruit and vegetables in common demand continue to be recorded each week for both shops and market in Suva, the prices being published in the local Press in accordance with instructions.

There has been a tendency for prices to increase during the quarter, this being in some instances due to seasonal shortages and in others to an increase in the invoiced price of imports. Rice is the only foodstuff that has fallen in price being 1d. to 2d. per lb cheaper than it was at the end of the first quarter of the year.

GRADING AND PACKING OF EXPORT CROPS

The following steps have been taken to improve the grading and packing of produce destined for export—

(*a*) A circular in Fijian on the selection and packing of bananas has been distributed to growers.

(*b*) An illustrated poster on the same subject has been prepared and is with the Government Printer.

(*c*) A circular on the harvesting, packing and handling of pineapples has been drafted, and

(*d*) Circulars on peanuts and ginger are in the course of being written.

STATISTICS

A monthly record of all local imports and exports of interest to the Department was maintained, the details being extracted from returns that are now received regularly from Customs.

Notes on various London market quotations are kept while much useful information on New Zealand markets is gradually being collected.

Assistance was given in the compiling of a schedule showing crop areas and values throughout Fiji over the period 1950–52.

SURVEYS

A survey was completed on banana prices in the Sydney and Melbourne Fruit Markets and on the charges likely to be incurred if the export of Fijian fruit to Australia were resumed; costings and other information on this subject was prepared for submission to the Secretariat.

A survey on rice marketing was completed and indicated briefly that—

(i) rice was primarily a subsistence crop, only a negligible proportion of the total production passing through normal trade channels;

(ii) the methods employed by growers in disposing of their surplus stocks would seriously hamper the running of an organized marketing scheme.

The possibilities of introducing an organized marketing scheme for any maize likely to be handled by the drying plant at Sigatoka were also investigated. A report was submitted stating that such a scheme was unlikely to operate satisfactorily while production remained at its present level.

NEW PROJECTS

The following investigations are being made—

Dried Ginger—The New Zealand market for green ginger absorbs as little as 10 per cent of the Colony's annual production which over the last few years has averaged 250 tons. A demand for dried ginger exists both in Europe and North America but recent experiments suggest that the loss in weight during the drying process will make it a less lucrative export than green ginger.

Experiments also indicate that fully matured rhyzomes are required to produce a satisfactory sample of dried ginger.

Coir—The Mat and Matting Manufacturers Association of the United Kingdom, who import between six and seven thousand tons of yarn each year, are seeking fresh sources of supply and have requested samples of retted and unretted fibre. Samples are being prepared and will be despatched in the near future.

Banana Flour—A sample of flour has been prepared from the thin, scabby unripe fruit rejected as unsuitable for shipment and despatched to the United Kingdom, Australia and New Zealand to obtain some indication of its commercial value.

Vau—Samples of this fibre have been sent to interested firms in London and Auckland in the hope that it may find a market as a substitute for raffia.

Fruit Juices—There exists a market for fruit juices in New Zealand though it is not yet known in what form they are imported. Samples of orange, lemon, grapefruit and mandarine juice have been prepared and will shortly be ready for despatch to interested firms in New Zealand.

It is hoped that it will be possible to investigate the commercial possibilities of further minor industries during the coming quarter.

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OFFICE AND WORKSHOP : **BY-PASS RD., WALU BAY, SUVA**

IMPORTED FOOD PRODUCTS 1953

(Expressed in c.i.f. Values.)

Commodity	Quantity	United Kingdom	Australia	New Zealand	Canada	South Africa	India Burma Malaya	Other Countries	Marketing Total
		£F	£F	£F	£F	£F	£F	£F	£F
Potatoes .. .. tons	2.093	46	37,075	47,183	7,086	....	....	87	91,477
Garlic .. .. tons	177	....	14,774	2,700	....	....	....	18	17,492
Onions .. .. tons	1,200	....	24,352	35,316	....	....	....	....	59,668
Spices .. .. tons	185	176	5,473	38	....	16	20,515	5,720	31,938
Rice .. .. tons	432	....	30,401	24	....	....	....	92	30,517
Pulses .. .. tons	1,063	....	28,746	7,427	....	....	39,750	131	76,054
Milk, Condensed Dried and Evaporated tons	528	17	73,454	50,379	....	....	....	....	123,850
Butter and Substitutes . .. .. tons	46	....	3,497	18,121	....	....	....	....	21,618
Ghee and Substitutes .. .. .. tons	170	....	8,502	69,478	....	....	....	....	77,980
Eggs .. .. doz.	20,579	....	3,265	1,911	....	....	....	....	5,176
Beef, Fresh and Canned .. .. tons	495	....	1,546	146,697	....	....	....	12	148,255
Pork, Fresh and Salted . .. .. tons	110	....	814	37,267	....	....	....	88	38,169
Fish, Fresh, Dried and Salted.. .. tons	23	524	339	3,717	281	88	244	2,061	7,254
	....	763	232,238	420,258	7,367	104	60,509	8,209	729,448

EXPORT OF PRINCIPAL CROPS 1953

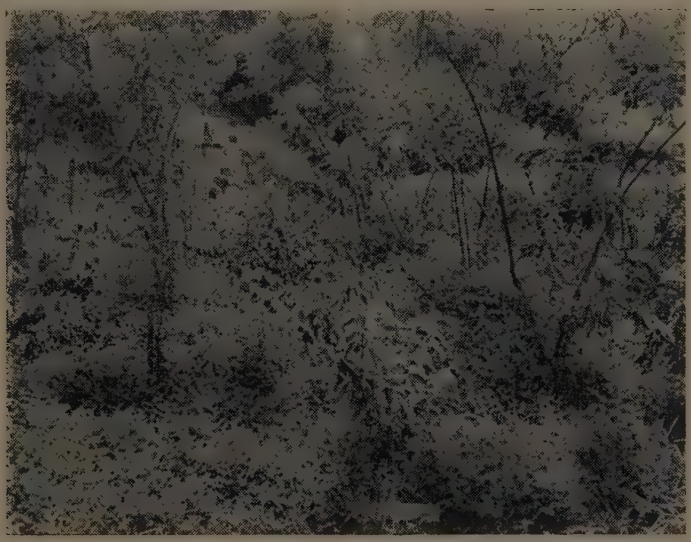
(Expressed in f.o.b. Values.)

Commodity	Quantity	United Kingdom	Australia	New Zealand	Canada	Western Samoa	Tonga	Other Countries and Ships' Stores	Total
		£F	£F	£F	£F	£F	£F	£F	£ F
Bananas .. .. cases	371,156	....	3	332,792	....	....	....	102	332,897
Copra .. .. tons	6,388	457,963	....	....	....	....	....	....	457,963
Coconut Oil .. .. tons	16,251	1,947,886	....	....	....	....	....	....	1,947,886
Coconut Meal .. .. tons	7,451	101,991	....	25,358	....	....	1	1,653	129,003
Fresh Coconuts .. .. No.	4,236	....	2	42	....	....	....	23	67
Raw Sugar .. .. tons	177,870	4,240,034	....	1,349,361	1,956,425	53,324	17,161	89,825	7,706,130
Molasses .. .. tons	39,850	....	45,833	....	....	....	....	15	45,848
Rice Bran .. .. tons	658	....	....	4,966	....	....	....	....	4,966
Canned Pineapple Juice .. .. tons	318	14,554	2,145	4,768	....	177	9	5,125	26,778
Canned Pineapples .. .. .. tons	624	2,761	5,663	61,449	....	516	39	12,414	82,842
Pineapple Syrup .. .. gal.	623	....	....	169	....	....	....	....	169
Fresh Pineapples .. .. .. cases	546	....	....	482	....	....	....	19	501
Peanuts .. .. tons	49	....	....	6,132	....	4,477	71	110	10,790
Peanut Meal .. .. tons	25	....	....	556	....	....	....	....	556
Green Ginger .. .. tons	26	....	....	939	....	....	31	2	972
Citrus Fruits .. .. cases	66	....	....	....	....	....	....	52	52
Arrowroot .. .. lb	2,052	....	....	76	....	....	....	....	76
Melons .. .. No.	12,998	....	....	2,022	....	....	....	118	2,140
Vegetables, Miscellaneous .. .. tons	318	....	....	3,963	....	....	....	4,477	8,440
Fresh Fruit Miscellaneous .. .. tons	52	....	....	245	....	....	....	1,979	2,224
	....	6,765,189	53,646	1,793,320	1,956,425	58,494	17,312	115,914	10,760,300

PLANT INTRODUCTION . . .

1. COFFEE

It is generally well-known that coffee grows very well in Fiji but it is surprising that with present high prices, there is not more interest in growing this valuable crop. There are two varieties established many years ago and now to be found in a semi-wild state in many parts of the Colony—and especially along the inland bridle tracks built by Brewster and his Fijian assistant many years ago. There are some excellent stands of Arabian coffee at Nadarivatu and Nadala—this species appears to grow well both in the highlands and near sea level in Rewa Province. The larger tree like Liberian coffee also flourishes but does not produce as good quality beans as the



Plot of young Arabian coffee of New Caledonian origin.

former. It is the latter which is recommended both for home and for commercial planting.

Seeds of several selections have been introduced for propagation at Naduruloulou where trials are also being conducted on problems of shade and cover crops suitable under local conditions.

The Plate illustrates a plot of young Arabian coffee of New Caledonian origin—two years old—planted in rows seven feet apart and interplanted with a species of *Leucaena* introduced from Curacoa in 1950. This latter is a small tree with light feathery foliage and is proving an excellent shade for coffee. The ground cover is creeping indigo (*Indigopera endecaphylla*) a fast growing legume of prostrate habit which provides an excellent cover for tree crops such as coffee or cacao. The area was previously clean weeded and subject to erosion in heavy rain. The cover crop has controlled this

and requires a minimum of attention. Wind breaks used in this area are hedges of *Hibiscus* and Cocoa—and also the poplar-like erect growing New Caledonian *drala*—*Erythrina fusca* var. *fastigiata* introduced in 1951. Vanilla introduced from Tahiti in 1952 is grown on the shade trees.

Seeds and seedlings of coffee and shade trees—cuttings of the cover crop and wind break trees are now available for distribution. Currently the Agricultural Officer Western is organizing the planting of coffee in eight koro in Ra Province for which seedlings are being raised at Naduruloulou and collected at Nadarivatu.

The coffee at Naduruloulou which has been pruned on the single stem system has borne a very heavy crop in its third year. All coffee trees are sprayed regularly with Bordeaux mixture as a protection against fungal diseases; but generally speaking coffee in Fiji is particularly free from pests and diseases.

The Naduruloulou plots demonstrate the classical system of culture involving the interplanting of the bush crop with first a temporary shade of Pawpaws and later a permanent shade tree associated with a permanent leguminous ground cover. In addition trials with selected strains of *Vanilla* planted to grow on the *Leucaena* are in progress.

Readers interested in the cultivation of coffee will be assisted in every way possible with information, seeds or plants.

There is a good demand for local coffee at present. —B.E.V.P.

Fijian Way of Life

BY

G. K. ROTH

O.B.E., M.Sc. (Cantab.), B.A. (Liverpool)
Colonial Administrative Service

188 pages, 30 photographs, 2 drawings and a map.

Oxford University Press, Melbourne, 1953.

This book deals with Fijian custom and contains a record of village life; of the contribution of Fijians to economic production; their social structure and its connexion with land ownership. There is also an account of the system of local government applied to the Fijians and of the part they themselves play in the administration of their own country.

Price 20/-

AVAILABLE FROM THE GOVERNMENT PRINTER AND FROM THE PRINCIPAL BOOKSHOPS IN SUVA.

2. BLACK PEPPER

Plate 1—Original Pepper Plant introduced 1951.

Many years ago efforts were made to establish black pepper at Nasinu but these appear to have been abandoned as, until recently, the plant was not to be found anywhere in the Colony.

During 1951, with the assistance of the Director of the Botanic Gardens, Singapore, and the Director of Agriculture, Sarawak, five cuttings of a high yielding strain were introduced (F.D.A. No. 13359) to Naduruloulou. These have been propagated and a considerable number of plants established in observation plots. Cuttings have also been distributed to Western Samoa and elsewhere outside the Colony. The plant is a root climbing ivy-like vine (Plate 1)—growth is rapid and fruit is borne within six months of planting out. The crop is heavy and easily harvested. The plant requires good, well-drained soil and must be grown on supports—preferably living, such as the kapok tree. Propagation is from cuttings which are normally not difficult to root and the crop would appear an excellent one for the small-holder in Fiji.

The supply of plants is as yet limited but facilities for propagation are being provided and it is hoped to be able to meet reasonable demands in the near future.

Plate 2—*Piper nigrum*—leaves and fruit at Naduruloulou 1954.

The fruits are collected daily and dried for the black pepper of commerce. Currently prices are high and it would appear that a good local market for properly prepared pepper is available.

—B.E.V.P.

3. PLANTS IN STOCK AT NADURULOULOU

PLANTS IN STOCK—30TH JUNE, 1954.

Price 2s. each delivered at Department of Agriculture, Suva, unless otherwise stated.

FDA	*Plants*	*Remarks*
13544	Cassia grandis	Bright pink shower
13669	Cassia nodosa	Pink and white shower
13668	Cassia bakeriana	Pink and white shower (Hawaii)
13680	Cassia fistula	Golden shower
13807	Cassia multijuga	Timor shower.
13270	Cassia laevigata	Buttercup bush
13866	Cassia javanica	Pink shower
13914	Jacaranda mimosaefolia	Ornamental tree
13925	Jacaranda mimosaefolia	Ornamental tree
14163	Jacaranda mimosaefolia	Ornamental tree
13722	Bauhinia sp—(Purple)	Butterfly trees and shrubs
13663	Bauhinia galpini	Bright red flowers
13772	Bauhinia candida	White flowers
13773	Bauhinia monandra	Purple flowers
13922	Bauhinia hookeri	
14050	Delonix regia	Flamboyant tree
13949	Tabebuia pentaphylla	Purple flowers
13949	Saroca indica	Red:
13785	Melia azedarach	Persian lilac-tree
13640	Lagerstroemia flos-reginae	Pride of India—tree
13649	Spathodea campanulata	African tulip—tree
13741	Tecoma stans	Yellow Elder—Shrub
13942	Cedrela australis	Cedar-wood—tree
13873	Melaleuca leucodendron	Ti—tree
13870	Tamarindus indicus	Tamarind: shade tree
13224	Aristolochia sp.	Dutchman's pipe: vine
13620	Antigonon leptopus	Mexican creeper: vine
13717	Mocelolo	Small tree
13874	Murraya exotica	Small tree—white flowers
13929	Stenocarpus sinuatus	Wheel-of-fire
	Clitoria ternatea	Butterfly pea—blue flowers
13941	Parkia roxburghii	Large tree with yellow flowers
13266	Agathis vitiensis	Fiji kauri pine
13641	Podocarpus vitiensis	Fiji pine
13750	Swietenia macrophylla	Mahogany: large-leaf
13844	Swietenia mahogoni	Mahogany: small-leaf
13305	Araucaria cunninghamii	Hoop pine
14012	Azelia bijuga	Fiji vesi—large tree
13642	Gmelina arborea	Shade tree
	Parinarium insularum	Fiji tree: makita
13072	Pinus merkusii	Pine—large tree
13663H	Erythrina ovalifolia	Tree: ornamental flowers
14149	Erythrina monosperma	Tree: ornamental flowers
13923	Erythrina tomentosa	Tree: ornamental flowers
	Calophyllum inophyllum	Fiji dilo tree
14008	Maniltoa grandiflora	Large Fijian tree. Cibicibi
13784	Kleinhovia hospita	Large Pink flowers
	Pithecolobium saman	Rain tree
13859	Albizzia saponaria	Soap-bark rain tree
13621	Albizzia falcata	Tea-box rain tree
13909	Cupressus benthamii	Cypress pine
13913	Cupressus benthamii	Cypress pine
13840	Citrus vulgaris	Wild lemon

FDA	*Plants*	*Remarks*
13015	Citrus sp. var. Namosi Orange	
13617	Citrus nobilis	Mandarin
13624	Citrus maxima	Shaddock
13279	Kusaie lime	} Budded trees 5s. each.
13279	Citrus vulgaris var. Molikula	Red lemon
13824	Fortunella japonica	Kumquat
	Persea gratissina	Avocado
	Mangifera indica	Mango—large tree
13801	Anacardium occidentale	Cashew nut—tree
	Anona muricata	Soursop: small tree
13814	Eugenia michelii	Shrub—edible fruits
13744	Coffea liberica	Coffee—liberica
13744	Coffea arabica	Coffee—arabica.
	Passiflora edulis	Passion fruit
	Passiflora quadrangularis	Granadilla
13764	Garcinia mangostana	Sour mangosteen
13572	Artocarpus integrifolia	Jak-fruit
14011	Canarium methenbethene	Java almond
13823	Averrhoa bilimbi	Tree-cucumber
13546	Punica granatum	Pomegranate
13647	Areca catechu	Areca palm
13619	Elaeis guiancensis	Oil palm
13590	Veitchia storkii	Fiji palm—vuleito
13625	Veichia joannis	Fiji palm—Niusawa
13856	Pimenta acris	Bay-oil tree
13628	Cinnamomum zeylanicum	Cinnamon
13259	Aleurites montana	Tung-oil: small tree
14483	Terminalia chebula	Large shade tree
13878	Sapindus sapenaria	Soap berry.
	Hydnocarpus anthelmintica	Choulmoogra oil tree
13826	Hydnocarpus wightiana	Choulmoogra oil tree
	Hura crepitans	Sand-box—tree
14148	Coccolobis uvifera	Sea grape
	Chlorophora excelsa	
14009	Gyrocarpus jacquini	Large Fiji tree—Wiriwiri
14181	Pritchardia pacifica	Fiji fan palm
13244	Pandanus sp. (Vadra solo)	Screw pine—red fruits
13565	Raphia vinifera	Raffia palm
13763	Cycas rumphii	Cycad—Fiji—Logologo
13984	Trachylobium verrucosum	Balsam of Peru—tree
13655	Camellia thea	Tea; bush

All orders should be addressed to the Director of Agriculture, Suva.

PLANT QUARANTINE (UNITED KINGDOM REQUIREMENTS)

The Importation of Plants Ordinance of 1953 requires all living plants (except seeds) when imported into England and Wales for planting to be accompanied by a prescribed Certificate of Health based on an inspection of the plants made within 14 days prior to the date of shipment. Order No. 513 of 1954 requires for all consignments except those consisting wholly of potatoes or forest trees or of plants which the period of active growth had ceased before the 1st day of June, 1954 an additional certificate that the plants were examined during active growth by a duly authorized official and found to the best of his knowledge to be free from injurious pests and diseases including virus diseases.

4. ROOT CROPS

A—*DIOSCOREA ALATA* (1953–1954) HARVESTED 30TH JUNE, 1954.

FDA	Varieties	No. of Hills	No. of tubers	Weight of tubers	Weight of largest	Weight of smallest
13162	Rewamoin Grii	....	18	17 lb	2½ lb	6 oz.
13200	Togovuso	2	2	1 lb	13 oz.	3 oz.
13201	Peya	15	16	7 lb	1½ lb	4 oz.
	Damuni	12	14	1½ lb	4 oz.	3 oz.
13084	Saukalabuci	20	14	3½ lb	12 oz.	5 oz.
	Vuraidra	12	18	2 lb	6 oz.	2 oz.
13204	Tabuani	6	15	1½ lb	6 oz.	2 oz.
13105	Taniela-vula-leka	2	4	6 oz.	4 oz.	2 oz.
13166	Poyai	9	17	3½ lb	9 oz.	4 oz.
13163	Guano mindui	15	15	19 lb	3½ lb	3½ oz.
13199	Taniela-vula-balavu	3	....	....	....	....
	Vasa	....	1	1 oz.	....	....
13164	Murapoe	54	77	147 lb	8½ lb	7 oz.
13088	Taniela damu leka	9	5	3¾ lb	21 oz.	7 oz.
13169	Riando	....	....	....	....	....
13167	Rewamoin	15	75	110 lb	7 lb	3½ lb
13168	Rewamoni Mi	114	104	118 lb	11 lb	6 oz.
	Koto	3	5	4 oz.	2 oz.	1½ oz.
13134	Taniela vula leka	4	....	....	....	....
	Koregu	6	2	6 oz.	4 oz.	2 oz.
13203	Kaumaile	18	23	26 lb	3 lb	1 oz.
13087	Keu	4	8	2 lb	9 oz.	3 oz.
	Voli kula	3	5	7 oz.	....	....
13086	Moala	3	....	....	....	....
13208	Veuwa	12	14	20 lb	2½ lb	7 oz.
13083	Sebu-ni-bau	6	7	1½ lb	7 oz.	3 oz.
13296	Bombay	22	26	96 lb	7½ lb	6 oz.
13085	Jamani	1	1	3 oz.	....	....
	Jamani (Kadavu)	1	1	3 oz.	....	....
	Voli vula	....	11	10 oz.	3 oz.	2 oz.

B.—*KAILE VAR.* (1953–1954) *DICOREA SETIVA.*

FDA	Varieties	No. of hills	No. of tubers	Weight of tubers	Weight of largest	Weight of smallest
13097	Kailevaya	....	6	13 lb	1½ lb	2 oz.
13071	Kaila tima	....	10	12 lb	3½ lb	6 oz.
	Kaile (Singapore)	....	3	5 oz.	2 oz.	1½ oz.
13070	Kaile mila	....	43	5½ lb	1 lb	1½ lb
13068	Kaile ni Solomone	....	74	14 lb	1 lb	2 oz.
	Kaile (Miss Holmes)	....	1	9 oz.	....	....

C.—OTHER ROOT CROPS.

FDA	Varieties	No. of hills	No. of tubers	Weight of tubers	Weight of largest	Weight of smallest
13069	Amorpophallus Campanulatus (Maruo)	....	14 lb	100 lb	18½ oz.	1 lb
	Ginger (Zingiber offianalis)	....	150 lb	....	....	....
	Ginger (Zingiber offianalis)	....	2 lb	15 oz.	....	....
	Ginger (Zingiber offianalis) (F.C.M.A.)	....	143 lb	....	....	....
	Polynesian Arrowroot (Tocca pinnatifida)	....	2 lb	5 oz.	10 oz.	1 oz.

5. INTRODUCED VARIETIES OF RICE

BY R. R. MASON

There are no indigenous varieties of rice in Fiji and all the varieties now commonly grown have been introduced within the last 50 years. Many were introduced casually or even by accident, and it is quite by chance that they have been suited to the local conditions of temperature, rainfall, and day-length in their various combinations through the growing season. It is therefore certain that improvements are more likely to be obtained by the introduction of suitable varieties than by selection within the varieties now grown. There is very considerable scope for testing further introductions from these countries which have already provided useful varieties, and possibly also from other countries in similar latitudes.

The qualities required are of course high yielding ability together with short strong straw and a fair resistance to shattering, and a fairly long grain since this betokens good eating quality. To fulfil adequately the different requirements of wet land and dry land, rich land and poor land, it is probably necessary to have different varieties for each condition; there should also be early and late varieties for each in order to spread the harvesting period, unless non-photoperiodic varieties are available. As opposed to this concept of one variety for one set of conditions, at the present time the majority of varieties show no such differentiation at all, being medium-term wet land rices with weak straw; it therefor appears that many of the poorer-yielding ones could be eliminated with advantage.

British Guiana has provided a number of varieties well suited to Fiji conditions. The first introductions, made in 1933, were of BG 75, BG 79, Ramcajara, Blue Stick and Demarara Creole; D116 was brought in a couple of years later(1). The first three have become popular and are widely grown but the others (which were never distribute to the public on a large scale) are usually slightly inferior in yield. Blue Stick in particular is marred by the ease with which the grain shatters and drops when ripe. Experiments at Koronivia(2) have failed to reveal any outstanding merits in these three, which have accordingly been dropped. On the other hand, Ramcajara and BG 75* can confidently be predicted to give better results than the older medium-term wet land rices such as Ram Bhog, Motmuria, or Karia. It is interesting to note that BG 75 is thought to have been introduced into British Guiana from India(3).

Three more varieties were received from British Guiana in 1950, and have been tested at Koronivia against BG 75, which they closely resemble. These varieties are numbered D54/42, D85/42, and D95/42. There were three trials in each year—early planted, midseason, and late planted in 1951–2, and in 1952–3 early and late planted, and drilled. The results are given below:—

REFERENCES:

(1) B. E. V. Parham—Ann. Bull. of Div. Reports, 1934, p. 49.
(2) N. Lamont—*Fiji Agric. Jour.*, Vol. 23, p. 66.
(3) "Rice in British Guiana", 1927–1932—Rice Bull. No. 1 of British Guiana, D. of Ag.

PROJECT E.B. 1/51.—(YIELDS IN CWT. PER ACRE.)

	1951–2			1952–3		
	Early	Mid..	Late	Early	Late	Drilled
Seed sown	24/10/51	21/11/51	15/12/51	6/11/52	17/11/52	21/11/52
Transplanted	13/12/51	4/1/52	24/1/52	11/12/52	24/1/53	....
Harvested	10/5/52	14/5/52	24/5/52	11/5/53	22/5/53	12/5/53
D 54/42	45·2	37·6	29·4	36·8	19·9	19·8
D 85/42	36·4	35·6	26·8	35·7	24·8	18·1
D 95/42	42·0	35·8	24·6	36·2	19·1	21·5
BG 75	44·0	35·8	27·4	35·3	28·1	21·9
Sig. Diff at 5 per cent pt. .	5·0	not significant		not significant		3·55

* Overseas readers please read BG 75 for BG 79 and vice versa.

Thus on two out of six occasions the variety D85/42 has been significantly worse than the established variety BG 75, while the other two have been neither significantly better nor significantly worse than BG 75. As they have shown no superiority in straw-strength or resistance to Rice Yellows, these three varieties have been dropped.

In 1952, a total of 23 varieties was introduced. Five were from Malaya and the rest were from the United States (mainly from Louisiana). In this first year they were grown as single plants, together with five of the best local varieties for comparison. Four blocks were used, with rows of approximately 25 plants; owing to the extremely early flowering of some of the American varieties, a wire netting cage was erected over one block to prevent bird damage (muslin bags having proved useless, as they prevented the grain setting). since the earliest grain was lost, the planting-to-flowering interval has been given as well as the maturation period. In the results given below, the figures for the yields of these American varieties refer to this one block only. It must be clearly understood that these yields do not provide accurate comparisons.

Seedbeds were sown on 5th November, 1953, and transplanted on 12th December, 1953.

Variety	Average No. of tillers	Heading period (days)	Average height (feet)	Date harvested	Maturation period (days)	Planting/ Flowering interval	Average yield per plant (oz.)
Local varieties—							
New Guinea	14	10	5ft 6in	4/5/53	180	144	2·08
BG 75	13	4	4ft. 10in.	14/5/53	190	155	2·21
Chiba Patna	13	3	5ft. 7 ½in.	26/5/53	202	169	2·04
Motka	20	4	5ft. 3in.	15/6/53	222	186	1·99
Bandala	12	3	5ft. ½in.	4/5/53	180	146	1·68
Malayan varieties—							
Siam 29	20	1	5ft 6½in	16/6/53	223	186	2·67
Serandah Kuning 5003 ..	17	3	4ft. 8in.	16/6/53	223	187	2·29
Nachin 5057	22	5	4ft. 11in.	9/6/53	216	183	2·01
Reyong 6	15	3	5ft. 2in.	22/6/53	229	186	2·21
Radinsiak 34	14	4	5ft. 3in.	14/5/53	190	153	1·81
American varieties—							
Caloro B	4	6	2ft. 7in.	25/3/53	140	69	0·08
Calrose B	3	6	2ft. 8in.	25/3/53	140	69	0·08
Colusa Pl 1600	4	7	2ft. 5½in.	25/3/53	140	69	0·04
Caloro A	3	6	2ft. 8½in.	25/3/53	140	69	0·08
Calrose A	3	6	2ft. 9in.	25/3/53	140	69	0·08
Blue Rose	5	8	4ft. 1in.	25/3/53	140	93	0·45
Lacrose	4	8	3ft. 11½in.	25/3/53	140	93	0·16
Magnolia	4	8	4ft. 4in.	25/3/53	140	93	0·15
Century Patna	4	6	3ft. 6½in.	25/3/53	140	96	0·20
Zenith	6	5	4ft. 4½in.	25/3/53	140	98	0·40
Rexark	4	5	4ft. 2in.	25/3/53	140	103	0·64
Blue Bonnett	4	6	5ft. ½in.	25/3/53	140	103	0·70
Blue Bonnett 50	4	6	4ft. 2½in.	1/4/53	147	103	1·00
Imp. Blue Bonnet ..	6	8	4ft. 3in.	1/4/53	147	105	0·76
Nira	5	7	4ft. 3in.	25/3/53	140	105	0·30
Fortuna	4	3	4ft. 10in.	1/4/53	147	109	0·48
Texas Patna	6	6	4ft. 4in.	1/4/53	147	110	0·84
Rexoro	5	8	4ft. 1in.	25/3/53	140	114	0·40

Plants of the American varieties were as poor and stunted as their miserable yields suggest and were regarded as completely unsuited to Fiji conditions. Recently however a curious fact has emerged in another rice trial in which monthly plantings are being made throughout the year in order to investigate the photoperiodiam of local varieties. The variety Blue Bonnet 50 was included in the faint hope that it might be better suited to planting at a different time of the year, and this does appear to be the case, although it is too early yet for conclusions to be drawn.

On the other hand, the Malayan varieties showed great promise and continue to do so this year in replicated variety trials. Not only are yields good but the straw strength of Serandah Kuning is better than that of any other variety in Fiji. Radinsiak is weaker than average and the other three are about average. Seed of these varieties is being multiplied while they are under trial.

The variety Mekheo was also introduced to Fiji in 1952, from New Guinea as a result of an attempt to find other varieties like the widely-grown New Guinea. While the origin of New Guinea remains a mystery, Mekheo was introduced by the Japanese and is grown in the Mekheo district. It is a dry land variety intolerant of standing water and appears quite promising. Being non-photoperiodic it is likely to be useful for growing in the dry season, but it has not yet been through a replicated trial.

In 1953 a variety resistant to salt water, named Pokkali was introduced from Ceylon; it appears to yield satisfactorily and seed is being multiplied before subjecting it to trials on marine swamps.

The recent work mentioned in this article was carried out by A. A. Ramnath Badlu, mainly under the direction of Mr. N. Lamont when the latter was Economic Botanist.

The assistance received from the South Pacific Commission and from the Departments of Agriculture of British Guiana, the United States and Malaya in making these introductions is acknowledged.

DRAINAGE RECLAMATION IN FIJI

Mr. P. McNee, Director of Irrigation and Drainage, Malaya, visited Fiji between February 13th and March 1st, 1954, at the request of the Colonial Office. His terms of reference were to advise the British Government whether reclamation of Fiji's swamp areas merited support from the special Rice Investigation Fund and, if so, to recommend ways and means of carrying out this work.

2. Mr. McNee considers that the potentialities of the Toga, Navua and probably some smaller areas, justify full investigations being made.

3. He recommends that in order to avoid involvement in questions of passages, accommodation and transport, the initial engineering survey be done by consultant engineers on contract but that at the same time, steps be taken to establish the nucleus of a drainage division of an appropriate Government Department. No drainage project can be expected to be successful, unless provision is made from the start for permanent adequate operation and maintenance of works.

Mr. McNee points out too that although purely engineering considerations are unlikely to occasion any difficulty, the effective utilisation of reclaimed areas and the recovery of developmental costs will involve agricultural and administrative issues that should be clearly defined before the projects are initiated.

5. Provisional estimates of the probable cost of such drainage survey of approximately 35,000 acres have been obtained. These involve a total of approximately £stg66,000. No estimate of the probable costs of drainage works can be obtained at this stage.

6. The whole matter is now being studied with a view to reaching a decision as to whether an application for funds should be made. —N.L.

NOTES FROM REPORT OF PLANT PATHOLOGIST, 1953

PLANT DISEASES IN FIJI

[The Plant Pathologist assumed duty in July 1953 and a large portion of his time has been taken up with gaining familiarity with the Colony, its crops and their diseases. Considerable time has also been spent on checking and indexing past records of diseases. Provision has been made for equipment for a laboratory which at the close of the year was in course of erection. *Ed.*]

Citrus canker, *wanthomonas citri* was recorded in Fiji by Mr. B. E. V. Parham in 1950. Eradication measures started in 1952 were continued and intensified by the Department in 1953. The previous records of the disease were for an area in South Eastern Viti Levu extending from Nausori to Navua. During the year it was found also in two isolated localities along the south coast of the island. Despite the setback due to diverting efforts from clearing the main area to these fresh outbreaks good progress has been made in the work of eradicating diseased trees.

Leaf spot, *Mycospherella musicola* and bunchy top were prevalent on bananas, the latter being a constant small drain on the productivity of banana plantings. As a general rule no attempt is made to control leaf spot and it may be largely responsible for the short economic life of banana plantings as well as being a threat to the quality of the fruit.

A rather severe outbreak of bud-rot of coconuts was confined to the Malayan dwarf variety and its hybrids which are used extensively on one plantation on Taveuni. The disease was more severe at altitudes about five hundred feet above the sea than at lower levels.

Maize rust, *Puccinia sorghi*, affected many crops. Usually the disease occurred late in the life of the crop after the development of the cobs and appeared to have had little detrimental affect. A few crops were seen which were affected earlier with consequent reduced yields.

Other diseases recorded during the year included:

Sweet Potato (Kumala); Mosaic.
Centrosema pubescens; leaf spot, *Septoria* sp.
Pumkin; Powdery mildew, *Erysiphe cichoracearum.*
Rhinoceros beetle; Green muscardine fungus *Metarrhizium anisoplice.*
Sunflower; Powdery mildew, *Oidium* sp
Coconut; Lightning injury.
Tomato; Spotted wilt virus.

—R.B.M.

COPRA DRYING*

The export price of copra on the world market is more or less governed by its quality, and especially by the contents of free fatty acids in the oil. It is estimated that one per cent increase in the free fatty acid contents of the oil, over and above three per cent, result in a total loss of two per cent on the copra price. This means that as Indonesian copra contains an average of four per cent free acids, there is an annual loss of about Rp. 12 mill. in foreign exchange. Improvements in drying, storage and transport could be effected through the co-operative societies. There were difficulties involved in introducing these methods into Indonesia.

* Houtman, J. P. W., (drying copra). Ekonomi dan Keuangan Indonesia 7, 2, p. 120/127 (1954).

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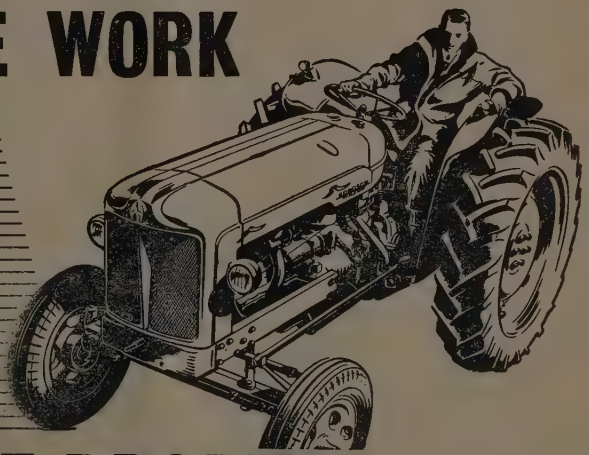

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LAND DEVELOPMENT . . .

LAND CONSERVATION BOARD

Following recommendations made by the Board and in accordance with the provisions of section 6 of the Land Conservation and Improvement Ordinance, 1953, the following Conservation Districts have been proclaimed with the membership indicated (R.G. Nos. 35 and 39).

Ba Conservation District No. 1.
The Soil Conservation Officer (Chairman).
Pundit Ram Kisor.
Ratu Josefata Naikere.
Mr. Ram Narain.
Mr. Bechu Prasad.
Mr. Shiu Prasad.
Mr. Churagou Singh.
Mr. D. R. Strong.
The Agricultural Officer, Western.
The Assistant Land Agent (N.L.T.B. Nadi).

Labasa Conservation District.
The Agricultural Officer, Northern (Chairman).
The Hon. H. B. Gibson, M.L.C.
Mr. G. Day.
Mr. Murali Kawaldhari.
Roko Tui Macuata.
Mr. Mahngu.
Mr. Guivar Prasad.
The Assistant Soil Conservation Officer, Labasa.
The Assistant Land Agent (N.L.T.B.), Northern.

Suva–Rewa Conservation District.
The Agricultural Officer, Southern (Chairman).
Mr. J. P. Bayly.
Mr. C. Yee Joy.
Uraia N. Koroi.
Mr. Balram Mishra.
Mr. Tasim Raja.
Mr. Dip Singh.

The functions of a Conservation Committee are defined (i.e. section 6 (*b*)) " to advise the Conservation Board on matters relating to the conservation of land and water resources in the area for which the committee is appointed ".

In accordance with section 13, the following have been appointed by the Governor as Conservation Officers.

Department of Agriculture.
The Soil Conservation Officer.
All Assistant Soil Conservation Officer.
All Senior Agricultural Officers.
All Agricultural Officers.
All Agricultural Assistants.
All Field Assistants.

Forestry Department.
The Conservator of Forests.
All Assistant Conservators.
All Forest Rangers.

Lands, Mines and Surveys Department.
All District Surveyors.
The Leases Inspector.

Native Land Trust Board.
Mr. N. Innes-Will.
Ratu A. R. Cawa.
Ratu I. Waqamakoba.
Ratu Orisi Narokete.
Ratu Joseva Toganivalu.
Ratu A. D. Naigulevu.

Colonial Sugar Refining Company Limited.
Mr. A. S. Hermes.
Mr. G. S. Robley.
Mr. N. K. Carew.
Mr. A. C. E. Hill.
Mr. M. F. Clay.
Mr. J. L. Chalmers.
Mr. G. M. R. Day.

The duties of Conservation Officers are defined " to assist the Board in supervizing land and water resources and encouraging the conservation and improvement of land and water resources ".

Under section 14 of the Ordinance a Conservation Officer " shall have the right at any time of the day to enter upon any land " for the purpose specified thereunder.

TWO EXAMPLES OF LAND USE IN FIJI

SOIL CONSERVATION ON A FIJIAN FARM

Travellers in the upper reaches of the Sigatoka River, on the lower slopes of Mount Bukelevu in Kadavu or along the rocky shores of Bua Province, have frequently noticed with surprise and interest the evidence of extensive terracing formerly practised by Fijians. Some of these terraces particularly those constructed to control water supply for the culture of dalo, of which excellent examples occur at Navakasiga, Moala and Kadavu, are still maintained and used. Consequently cultivating on the contour by means of terracing (Tavata) has not been altogether difficult to introduce to the present generation of Fijians, particularly those who were trained by the Department as students during the periods 1932 *to* 1947.

The present note records an example of contour farming carried on by one of these men on his own initiative and without technical assistance or special equipment. The area is generally hilly, the soil is comparatively poor, with more fertile areas on the lower slopes and in the valley bottoms.

It is typical of a large part of the wet zone provinces of Tailevu and Naitasiri in south-eastern Viti Levu, where nearly all the highly fetile arable alluvial flats have been alienated from Fijian occupation used at present for sugar cane and rice production.

The crops grown in these lowland hilly areas are bananas, pineapples, *yaqona*,* citrus and other fruit trees, root crops, especially tapioca, some dalo and sweet potatoes and a variety of vegetables. Food gardens are usually quite small, sited on well chosen slopes and surrounded by rough vege-

Photo R. Wright

Plate 1.—A corner of a Fijian cultivation—Naqeledamu 1952.

tation of grass and secondary tree growth. Savenaca has been farming on the contour for nearly twelve years, during which time he has supplied military and civilian markets with large quantities of produce. He has established an orchard of tree crops, avocado, citrus (budded grape-fruit, orange and mandarin) and coffee. He is the first Fijian in Viti Levu to undertake the planting of cocoa. Commencing in February 1953, he has established 640 trees of *Forastero amelonado* type in contour plantings which he plans to extend to at least 10 acres. He is also planting black pepper which is a new crop for Fijians.

The example set by his extensive hillside farming has encouraged other Fijian cultivators in the vicinity to plant their food gardens on the contour also.

His equipment comprises the usual hand tools, spade, fork, knife and hoe, a pair of bullocks, plough and harrow and most of the work is done by himself and a brother. He is a director of his co-operative association and a member of the Agricultural Advisory Council.

SOIL EROSION ON A CHINESE MARKET GARDEN

Writing in 1948, during a vist to Fiji, Dr. K. B. Cumberland(1), the noted New Zealand Geographer and Soil Conservationist, cited " the market garden districts of Tamavua and Nasinu are perfect examples of how valuable soil is destroyed . . . thrashed and ill-used ". until it disappears altogether " to reveal the ugly naked grey surface of the bed-rock ".

Many such cases of soil degradation occur throughout the Colony; but nowhere more extensively than in the districts of Suva and Naitasiri, for several miles along both King's and Prince's Roads and in the area between them. The culprits are rarely Fijians but it is usually Fijian-owned land leased to other races which suffers most. Market gardening is largely in the hardworking hands of Chinese,

Photo R. Wright

Plat 2.—A corner of the citrus orchard with tapioca fields beyond—Naqeledamu; 1952.

Photo R. Wright

Plate 3.—Contoured hill-slopes at Naqeledamu, 1952.

who in spite of their reputation as efficient gardeners, appear in Fiji to be most careless and negligent, if not entirely ignorant, of the simplest method of soil conservation.

The general pattern of land-use practised by these people is to secure a short-term lease of virgin or second growth forest on chocolate or black " soapstone " soil, to fell and burn off the vegetation cover even on the steepest slopes—to dig the soil by hand, forming it into beds with drains running up and down the hills, rarely if ever on anything approaching the contour—and to plant intensively a high-yielding crop which requires frequent clean weeding. Such crops are predominantly vegetables—cabbage, both European and Chinese, beans, carrots, turnips, sometimes peanuts, or pumpkins.

Gully and sheet erosion are usually rapid and progressive. Even with the aid of ferilizers and manures (blood and bone), soil fertility is rapidly lowered; and succeeding crops planted, usually dalo, tapioca and sometimes sweet potatoes, further deplete the soil resources.

Within quite a short period, from two to four years, extensive areas are denuded down to the underlying rock; and thereafter the remaining soil is heaped into beds of steadily diminishing size, always oriented on an axis most favourable to further erosion and loss.

Thus, within all too short a time in the life-span of Chinese tenants or Fijian landlords, a productive resource built up over vast ages in the past, is totally destroyed and nothing left for succeeding generations but a barren hillside, weed infested and useless. The restoration or renovation of such areas presents a problem so baffling that it is usually passed by on the other side. Ordinary long or bush fallow promises but little —complete closure and grassing is a better solution.

Photo B.E.V.P.

Plate 1.—Chinese cultivation at Colo-i-Suva, Prince's Road, 1953—sheet and gully erosion following one year of cropping. Cabbages and egg-plant on upper slopes, sweet potatoes and pumpkins below.

To demonstrate better methods of soil utilization and management on these critical areas, steps are now being taken to establish a conservation programme on a strategically selected site, typical of the region. Here, in a careful contour lay-out of terraces, drains, contour hedges, strips and stop-banks, crops normal to the area will be grown and some pasture established. It is hoped that the recently appointed District Soil Conservation Committee will exert a valuable influence towards a better understanding of the problem by those most vitally concerned, not only the tenant but also the landlord.

—B.E.V.P.

REFERENCE:

K. B. Cumberland—"Soil Erosion and World Food Situation." Trans. Fiji Soc., Vol. 4, No. 1, p. 4—1948.

Photo B.E.V.P.

Plate 2.—Another part of the same area—dalo planted as second crop after vegetables—advanced gully erosion evident.

AN OUTSTANDING EXAMPLE—SIGATOKA, 1954

SIGATOKA—1954

While Councils, Conferences and Committees debate ways and means of bringing into production the guava-infested alluvial flats of the Sigatoka river, a former trainee of the Department of Agriculture has demonstrated in six months that the only essential requirements are a modest capital, and hard work intelligently applied.

Mainly as a result of uncontrolled cattle grazing, large areas of fertile river flats are now useless and unproductive, under a dense cover of heavy guava, ten to fifteen feet in height. One farmer secured the unexpired portion of a lease of 27 acres of such country, the whole of it under this type of guava.

Clearing operations commenced in February 1954. With the employment of four men and a pair of bullocks, the guava was cut and pulled from ten acres, and stacked around the area to form a stock proof hedge, at a cost of £15 per acre. First ploughing of the ten acres was done by a hired tractor at a cost of £2 per acre. All subsequent cultivations and planting were carried out by the farmer himself with a bullock team, and one man permanently employed.

By mid-August 1954 the farm carried the following well-tended crops at varying stages of maturity.

3½	acres	potatoes
2½	,,	tobacco
1	,,	cabbages
1	,,	tomatoes
2	,,	various marketable vegetables and condiments.

At a conservative valuation these would be worth £750.

Advice and assistance was rendered by the Department in insect pest control.

The transformation of this area in so short a time is remarked by all habitual travellers on the valley road. —A.D.M.

TWENTY YEARS AGO

The following note, dated 10 April, 1933, records the beginning of organized Fijian effort at Lobau on the Sigatoka River.

"Many people, including Fijians, say that instruction work is largely wasted as the native will not persevere. There are many indications that such is incorrect like all sweeping assertions and the example of the young men at the Agricultural Department's Instruction Centre at Lobau, Bemana, should encourage others.

Eighteen months ago this centre was commenced with nine youths selected by the Bose ni Tikina. They have worked as free men under their own leader—the Government's share being to supply advice and the advance of implements. From a wilderness of guava and guinea grass they have won 34 acres of thoroughly cultivated fields yielding a rotation of crops. Thirty-eight horses and seven bullocks have been trained. Money received from crops to date has been £82 18s. 0d.

Now the point worthy of note is that the nine workmen with no compulsion have worked steadily and continue to work with enthusiasm, though the only pocket money they have received has been a total of £3 17s. 6d.

They have accepted a strict discipline of tasks for lateness or absence without leave, and for a year no leave was granted. That the Tikina has paid their taxes and for a number of implements from the proceeds of the crops is not a detraction of their keeness, as young men do not regard such things highly.

In the science of agricultural policy it is accepted that such training centres provide the best recruiting ground for native assistants, but unfortunately there are few paid positions available for such men. After the first few months other districts began to ask for help of boys from this centre and generously they offered to go where sent without pay. Most of the men have in turn taken duty without recompense and of these three have won paid positions as Government or Provincial servants in Colo West and Colo North. Three others are at the time of writing asisting without pay."

SHARE CROPPING*

In the Southern States of America, large estates have in a number of instances been divided into small holdings and cultivated by tenants on a share cropping basis.

The system is based on close personal relationship between the owner or overseer and the cropper, and offers an approach to the problems of bringing supervision, credit and mechanization firstly to farms which would otherwise be too small and secondly to farmers who are not sufficiently developed to enjoy these advantages without outside assistance: it provides efficient supervision of low income "farmers" and the rapid introduction of new technical advantages.

Share cropping can be operated in two ways, viz.—

(i) the landlord contributes half of the expenses generally in the form of quarters, implements, seed and fertilizer, the crop being divided equally between the two parties;

(ii) the landlord risks all operating capital and receives 2/3 of the crop, the remainder going to the tenant.

It would appear to be the normal practice in America for the landlord to provide the cropper with credit to finance the latter's share of operating expenses, to buy food, clothing and other necessities from the date of the arrangement until the first crop is harvested. It can therefore be said that the cropper need have no capital to start farming.

Close supervision of the cropper appears very necessary; the landlord and cropper know in advance what proportion of the crop each will receive, any benefit from additional efforts and managerial ability being shared by both parties.

The advance in mechanized farming has resulted in a tendency to revert to the operation of estates by wage labour and the centralization of plantation services.

* Notes abstracted "Farm Rental Arrangements in Georgia", by J. C. Elrod, D. E. Young and W. T. Fullilove, Bulletin 220, Georgia Expt. Stn.

ERRATUM

With reference to the article "The Soils of the Navua plains and their Chemical Status" appearing in Vol. 25, (Nos. 1 and 2) the following correction to the table facing page 36 should be noted:—

The heading to column 9 should read:

$$\frac{\text{Acid Soluble } P_2O_5}{\text{Total } P_2O_5} \times 100$$